POWER

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Can't Pry Him Loose!

Suggested by EVERARD BROWN, *Pittsburgh, Penna.*

New Penn Central Power Co.'s Williamsburg Plant

By Warren O. Rogers

SYNOPSIS—This plant is equipped with the most modern machinery and indicating and recording instruments. It has three 800-hp. water-tube boilers with space for a fourth. There is one 5000-kv.-a. turbine with provision for a second. The plant is designed for 20,000 kv.-a., the piping, etc., being laid out with the view of future extension. All condensing apparatus and most of the piping are in the basement. The piping layout is as simple as is consistent with good engineering, and the plant is uptodate in every respect. Air for cooling the turbo-generator is cooled and washed. A small turbine-driven 125-volt emergency lighting unit is installed on the switchboard gallery.

Modern throughout is the new steam-turbine power plant of the Penn Central Power and Transmission Co. at Williamsburg, Penn., about 22 miles from Altoona and about 15 miles from the Warrior Ridge steam and hydro-electric plant, which is also operated by the same company.

The location of the plant was governed in the main by the availability of water free from mine contamination. Prior to building, the country roundabout was searched for a suitable site, but the streams available were already polluted with mine water or would be. At Williamsburg, the Juniata River, the source of which is in territory unaffected by the mines, is clean and of good quality for boiler feeding and for condensing purposes. Although the stream is small, tests have shown that even during the driest season there will be at the lowest known water stage enough water to operate two turbine units at full capacity. When conditions warrant, a 9-ft. dam will be built across the river to form a storage basin, and a system of spray nozzles for cooling the condensing water will be installed that will supply the demand for water for as many units as the plant will ultimately contain.

At the rear of the building is the river, and in front are the railroad tracks. The structure, Fig. 1, is of brick and steel, and concrete has been used extensively. But little wood has been employed. A natural rock foundation exists under the building, and the basement

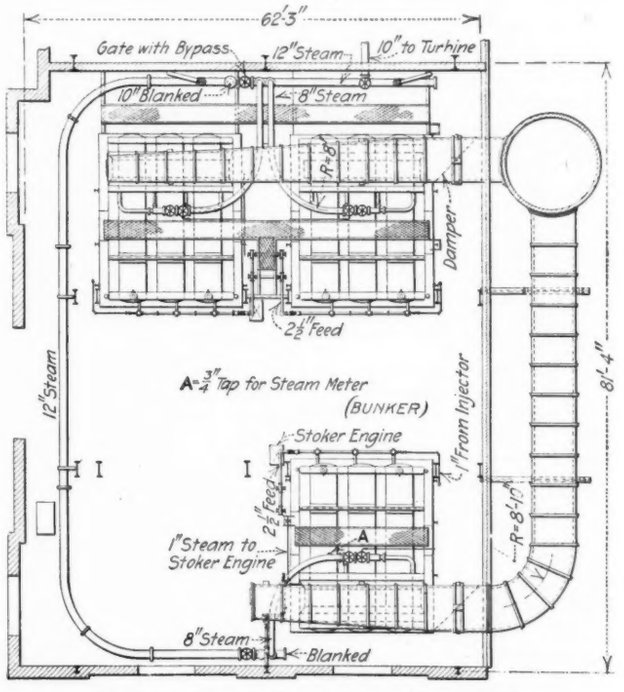


FIG. 3. PLAN OF THE BOILER ROOM

is at approximately the original ground level. The building is 81 ft. wide, 138 ft. long and 79 ft. high from the ground to the top of the monitor.

Boiler-Room Equipment

Three water-tube boilers, containing 8165 sq.ft. of heating surface and rated at 800 hp. each, are at present installed, with room for a fourth. Fig. 2 is a view of the boilers, stokers and coal-weighing apparatus.

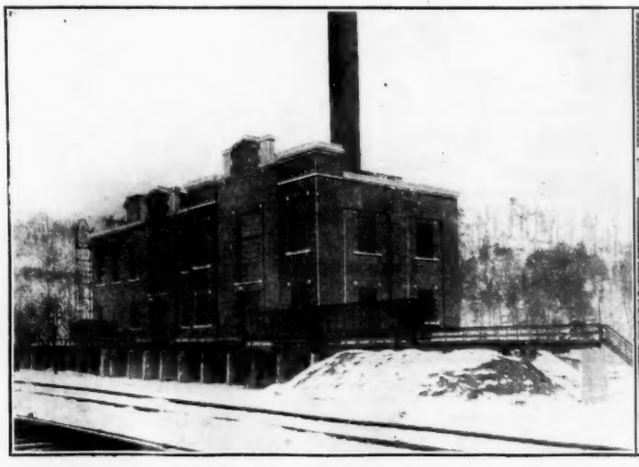


FIG. 1. EXTERIOR OF POWER PLANT, SHOWING COAL TRACK

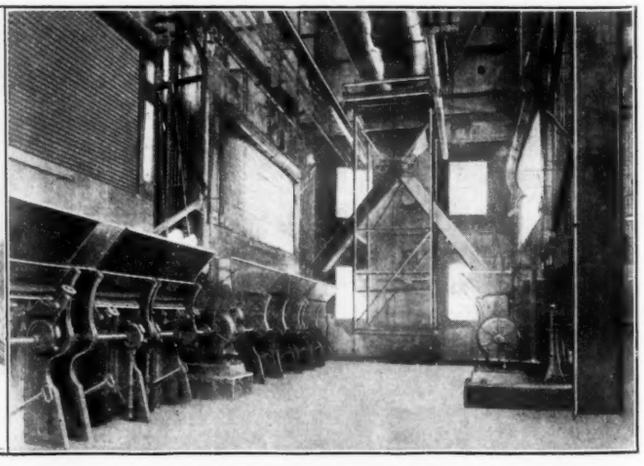


FIG. 2. VIEW OF THE BOILER ROOM AND WEIGHING-SCALE

Each boiler is equipped with a superheater capable of raising the temperature of 24,500 lb. of steam per hour 140 deg. F., and 50 per cent. more with a temperature variation of not over 10 deg. Under normal conditions each unit will evaporate 32,000 lb. of water per hour, or 3.9 lb. per sq.ft. of heating surface.

Each boiler furnace has two mechanical stokers, with an area of 62 sq.ft. of grate surface each, or 124 per boiler, which provides 1 sq.ft. of grate area to each 65.8 sq.ft. of boiler-heating surface. The furnaces are each 7 ft. 6 in. wide, 8 ft. 9 in. long and 10 ft. high. ft. 6-in. space between and a 20-ft. space between the fronts. This gives ample room for the operation of the 2-ton traveling weighing-scale, which is fitted with two discharge chutes so as to discharge to the stoker hoppers of both rows of boilers. The traveling scale is suspended from the top and runs on a track hung from the steel frame of the building. The fuel is taken from an overhead coal bunker of 312 tons' capacity, or 6 tons per running foot.

The boiler tubes are cleaned by a system of tube cleaners, and the temperatures of the furnaces and waste

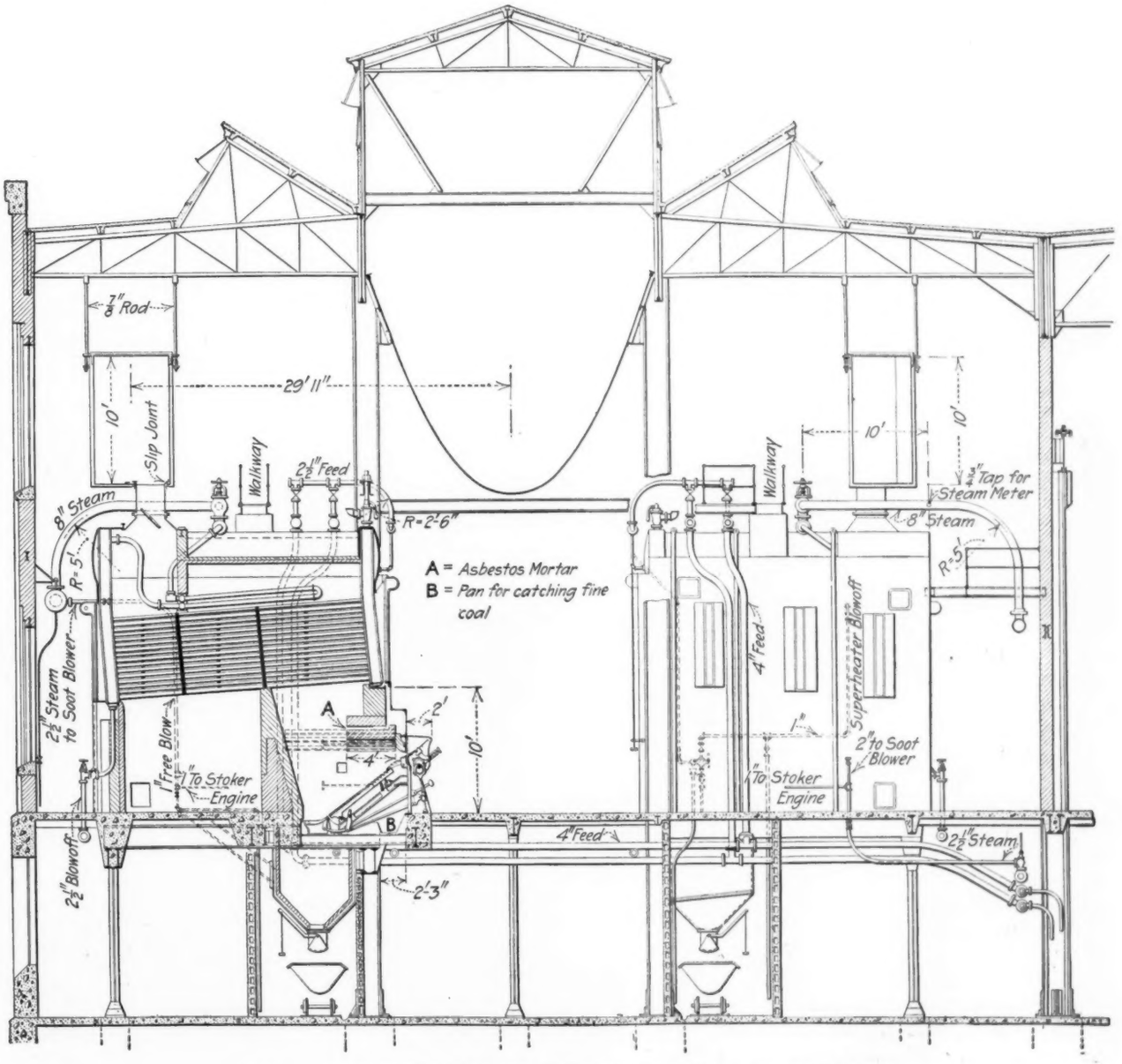


FIG. 4. SIDE ELEVATION OF THE BOILER ROOM AND BASEMENT

As the stoker used is not built in extreme widths, two are placed under each boiler with an 18-in. dividing wall between, making practically two furnaces. This has the advantage of permitting cleaning one fire without disturbing the other. Furthermore, in case one stoker becomes disabled, the other will maintain the boiler at one-half of its capacity until repairs are made.

A plan and an elevation of the boiler room are shown in Figs. 3 and 4. The boilers are placed singly with a 6-

gases are ascertained by a recording electrical pyrometer. Steam meters on the outlet of each boiler and indicating and recording draft meters give the fireman the information necessary for the most efficient operation of the boilers. The recording meters also afford the chief engineer an opportunity to determine the trouble and correct it, in cases where the efficiency falls below the established standard. Tests are being made to fix this standard, which will be about 72 per cent. com-

bined efficiency of boiler and furnace. The water columns are illuminated by concealed lamps, and the steam going to the main header from each boiler is metered.

Two of the boilers are connected to a metal smoke flue, 3 ft. 6 in. wide and 7 ft. high at the inner end and 10 ft.

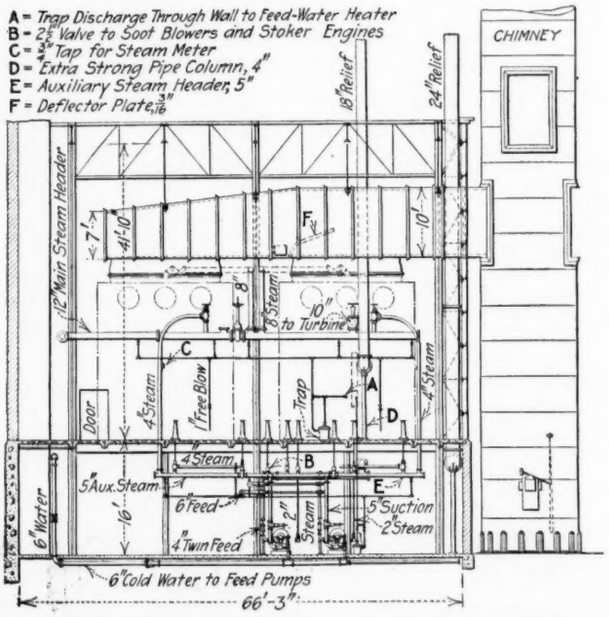


FIG. 5. REAR ELEVATION OF BOILER SETTING AND PIPING

6 in. high at the stack. This flue is extended directly to the steel, self-contained, brick-lined chimney, which is built outside of the boiler house. This chimney is 225 ft. high and 12 ft. in diameter. The single boiler is served by a tapering smoke flue, 4 ft. 6 in. wide at the inner end and 10 ft. high; it enters the stack with the same dimension as the other. The arrangement is shown in Fig. 3. When another boiler is installed at the vacant space, the only change to be made in the smoke flue will be that of connecting an extension.

The present arrangement has been designed with the idea of taking care of future extensions of the plant, which ultimately will contain nine boilers and four turbine units. When this is brought about, the temporary back wall will be removed and the building extended toward the river. This will bring the existing chimney central between four boilers, two connecting to it from each side, for which provision has already been made. The part of the smoke flue from the single boiler to the chimney which is outside of the building at present will be removed and the flue over the boiler will be extended to take in the future boilers along the north wall. A second stack will be built opposite the present one, but outside of the building, to receive the gases from the five boilers that will eventually be installed along the north wall.

Provision has been made for expansion and contraction of the smoke flue above the boiler by making the connection between the vertical uptake and the horizontal flue in the form of a slip joint. The weight of the flue is supported by ⅞-in. rods hung from the roof girders. A spring is used at the end of each rod with a tension sufficient to relieve the slip joint from binding. On the interior of the flue there is a $\frac{3}{16}$-in. deflector plate *F* between the uptake of the two boilers to prevent countercurrent of escaping flue gases. This is shown in Fig. 5.

Coal-Handling Equipment

Bituminous coal is used containing 14,000 to 14,400 B.t.u. and averaging 8 per cent. ash. It is delivered to the plant from a spur track that terminates at the near end of the plant, Fig. 1, and is supported on concrete piers. A track scale for weighing the cars is installed on this trestle. At the end of the building, under the loaded car shown, is a hopper from which the coal is discharged by means of an apron feeder into a set of crushing rolls. It is then delivered to a bucket conveyor that discharges to a scraper conveyor running over the bunker in the boiler room. Openings are provided in the bottom of the scraper trough for the discharge of the fuel. The conveyors have a capacity of 40 tons per hour. The scrapers require no attention, as when the bunker is full under one opening, the coal is carried along to the next one. Eventually, the spur track will be extended to permit of a storage area to provide against a coal shortage. The storage coal will be handled by a locomotive crane to the crusher hopper. Ashes from the stokers drop into brick-lined hoppers from which they are discharged into cars and used for filling-in purposes.

Boiler Operation

The boiler plant has not been tested out for general performance, but complete records are kept and progress is being made toward higher efficiency. At present about 65-per cent. boiler and furnace efficiency is obtained with an evaporation of about 8.1 lb. water per pound of coal and a flue-gas temperature of 550 deg. This is not satisfactory, and certain slight changes are being made and various coals tried out, with the idea of raising this efficiency and maintaining it at about 72 per

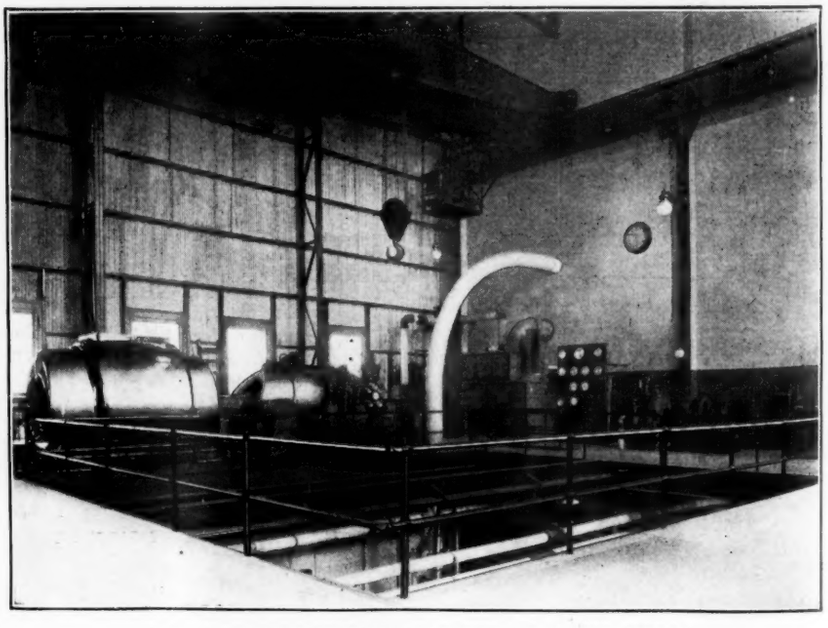


FIG. 6. GENERAL VIEW OF THE TURBINE ROOM

cent. The size of the units in comparison with the loads carried makes this difficult, but this condition will improve as the plant grows and a better balance is obtained between the electric and steam-generating equipment.

One fireman is employed on each watch. The plant at present runs until 11 p.m., after which the load is carried by the Warrior Ridge plant. One man is employed to handle the 50 tons of coal consumed each day to the bunker, to remove the ashes and to assist in cleaning fires.

Turbine Room

At present but one turbo-generator is installed. It is of 5000 kv.-a. and generates three-phase, 60-cycle, 6600-volt current at 3600 r.p.m., Fig. 6. The turbine is bladed to give a water rate of 15.6 lb. with a load of 3300 kw., and a maximum capacity of 4800 kw. With the present equipment there is one boiler horsepower for each 2.08 kw. of turbine capacity. With but two boilers in service there is provided one boiler horsepower for each 3.12 kw. in turbine output.

Air for cooling the generator is taken in at one end of the building and cooled and washed to eliminate dust particles and impurities. The air washer is in the basement and at one end of the turbine foundation, so that the air has a direct passage to the air chamber below the generator. The washer has a normal capacity of 26,000 cu.ft. per min. It is 8 ft. 10 in. wide, 7 ft. 1½ in. high and 10 ft. long and forms a part of the steel duct for carrying the cooling air from outside the building to the generator. Special dampers have been installed at the inlet of the washer so that the air can be taken either from outside or inside of the building. This is necessary, as the washer will freeze when the air entering it is below about 35 deg. F.

The air entering the washer is thoroughly mixed with sprays of water and is then passed through the eliminators where the mixture of air and water spray is drawn through thin spaces between corrugated-metal sheets; the sudden changes in direction of the air current cause the spray to be deposited on the plates, leaving the air saturated, but with no suspended water in it. The process of washing eliminates about 95 per cent. of the dirt in the air and reduces its temperature to that of the wet-bulb thermometer.

Next to the boiler-room wall in the turbine room is the metering and recording feed-water heater, with a capacity of 200,000 lb. of water per hour. The water is raised from 60 to 200 deg., a difference of 140 deg. between the entering and discharge temperatures. This heater is equipped with a metering heater, which records the amount of water that is drawn from the heater by the feed-water pump and pumped to the boilers. This record is used in calculating the performance of the boilers and also for checking the overall economy of the plant.

Along the same end of the turbine room are two 50-kw., 125-volt exciter sets, one driven by an induction motor, the other by steam turbine. The motor-driven set is used under normal conditions, but whenever thunder storms or any other disturbance that may cause trouble on the transmission lines is reported by the substation operators, the steam-driven exciter is put in service until all likelihood of trouble is past.

Basement Equipment

All condensing and pumping apparatus is in the basement. The main turbine rests on a concrete foundation, box-shape, with one end left out. The side walls are 2 ft. thick and 29 ft. 3 in. long. The surface condenser is placed between the foundation walls, with the water-discharge end protruding about 3 ft. The 24-in. atmospheric relief pipe is taken from the side through the concrete wall. The condenser has 10,000 sq.ft. of cooling surface composed of 1-in. tubes 16 ft. 8 in. long. The amount of circulating water passing through the condenser is 7000 gal. per min., and the quantity of steam to be condensed under normal conditions is 62,000 lb. per hr. Under maximum load of 4800 kw., 75,000 lb. of steam per hour must be condensed. The temperature of the circulating water is raised about 20 deg. F. under normal load conditions. The vacuum has been maintained within 0.9 in. of the barometer, but normally runs about 1.3 in. Better results are expected after certain troubles with the suction line to the circulating pumps are overcome.

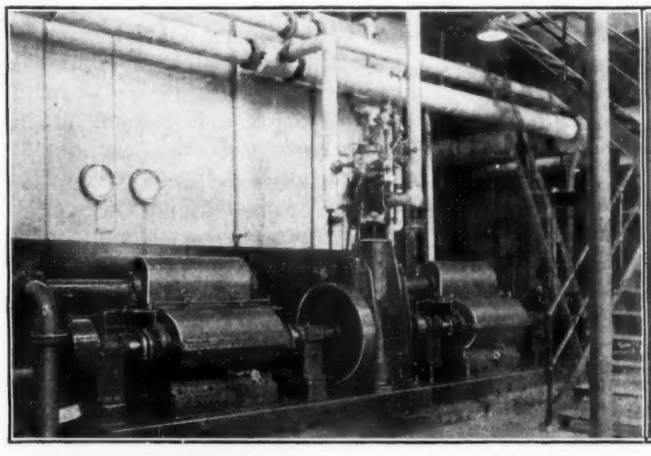


FIG. 7. ENGINE-DRIVEN ROTREX AIR PUMPS

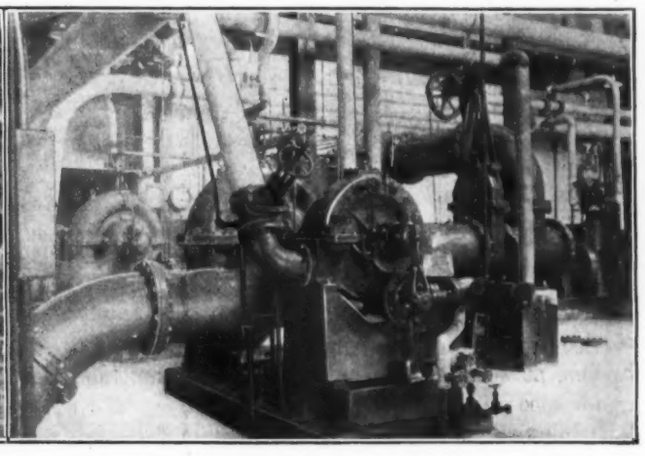


FIG. 8. TURBINE-DRIVEN CIRCULATING PUMPS

Two 18x36-in. rotrex air pumps, engine-driven at 225 r.p.m., are arranged alongside the concrete wall which incases the condenser, Fig. 7. The condensate, which is drawn from the condenser by these pumps, is discharged into a concrete hotwell below the floor, from which the hotwell pump raises it to the feed-water heater. The two 18-in. circulating pumps, each with a capacity of 7000 gal. per min. are driven by two 90-hp. Terry steam

turbines at 1650 r.p.m. Fig. 8 is a view of these units. Fig. 9 is an elevation of the boiler-feed pumps, also showing the arrangement of the feed-water heater and exciter units. The two 3-in. 3-stage centrifugal boiler-feed pumps are each driven by a steam turbine at 2900 r.p.m., the capacity of each pump being 250 gal. per min.

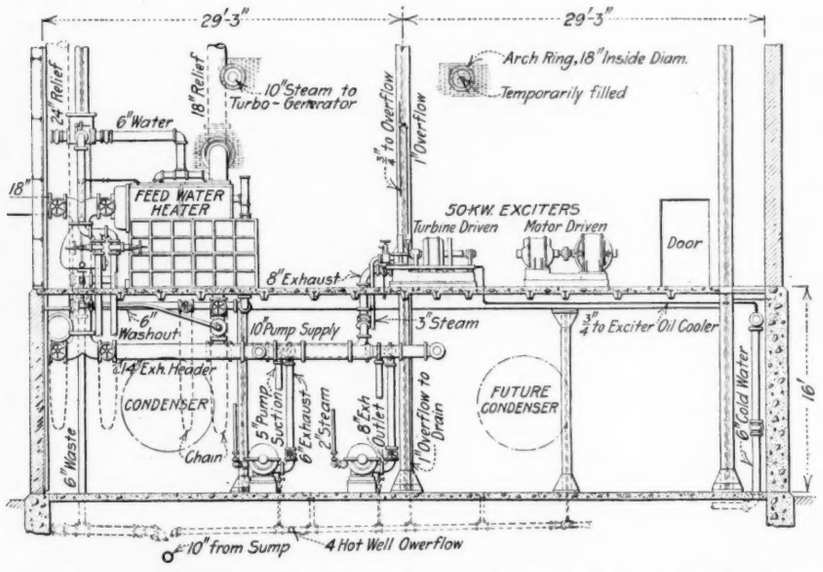


FIG. 9. PIPING OF BOILER-FEED PUMPS, FEED-WATER HEATER AND TURBINE-DRIVEN EXCITER

In front and between the circulating pumps are two motor-driven, 3-in. centrifugal, single-stage, hotwell pumps, which operate at 1800 r.p.m. Each pump has a capacity of 250 gal. per min. Water for general use around the plant is supplied by two 4-in. single-stage service pumps, Fig. 10. One is driven by a 20-hp. steam turbine at 2000 r.p.m., the other by a 20-hp. induction motor at 1800 r.p.m.

Drinking water is supplied at drinking fountains in the turbine and boiler rooms. It is obtained from a spring that was encountered in excavating for some of the foundations and is supplied to the fountain by a small motor-driven centrifugal pump. It has been examined and pronounced excellent for drinking purposes and is always cool enough for use without ice.

Steam-Piping Details

Details of the piping are shown in Figs. 11 and 12. The main 12-in. header in the boiler room is blanked at the tee, where the 8-in. steam line from the boiler connects with a 5-ft. radius bend at the rear of the single boiler. The header is carried to the front of the boiler room and looped around to the rear of the two boilers, which are connected with it by 8-in. pipes, Figs. 3 and 4, at a point central between the two boilers. The end of the header is blanked for extension when other boilers are installed, the ultimate arrangement being that the main header will form a loop around nine boilers. Section valves are installed to cut out parts of the header in case of trouble.

A 10-in. line is taken from the header to the turbine in an 11-ft. 6-in. radius bend, and provision has been made for a line to a second turbine, the outlet of the tee being blanked. Two 4-in. branch lines connect the main header at the ends of a 5-in. auxiliary header in the basement. Section valves in this 5-in. header provide for supplying steam to all of the auxiliary apparatus in case any one of the three present boilers is out of service.

Two 4-in. auxiliary steam lines extend the length of the basement. One supplies steam to the engine driving the air pump through a 2-in. branch; a 3-in. line connects with one of the 90-hp. circulating-pump turbines. The other auxiliary steam line is fitted with an outlet for the future air-pump engine, and besides supplying steam to the second 90-hp. turbine-driven circulating pump, branches, through a 1½-in. pipe, to the turbine driving the service pump. The arrangement is shown in Fig. 11. The two lines are tied together over the circulating pump and this tie, together with the section valves in the 5-in. header, insures a supply of steam to the auxiliaries at all times.

The stoker engine for the single boiler is piped direct to the main steam header behind the boiler. In addition, it is connected to the 5-in. auxiliary header. The other stoker engine is connected to two sections of the 5-in. header, thus assuring a dependable steam supply.

Drip piping is run from each section of the main and auxiliary steam headers to traps which discharge either to the feed-water heater or into the boiler blowoff line in case the heater is out of service. Free blow-pipes are also

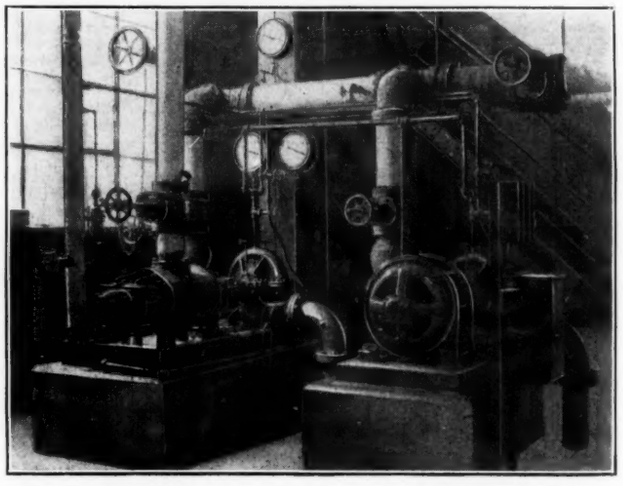


FIG. 10. TURBINE- AND MOTOR-DRIVEN SERVICE PUMPS

installed for clearing the main lines of water and air when starting up.

Exhaust Piping

A 24-in. relief pipe from the main turbine extends above the roof, and an 18-in. relief pipe runs from the heater to the atmosphere, both passing through the wall to the rear of the boiler and extending through the roof. Exhaust steam from the auxiliaries is discharged into two 6-in. exhaust lines which increase in size to 8 and 12 in., and to 14 in. in the exhaust header which connects to the feed-water heater.

The exhaust line from the air-pump engine is 2½ in., that for the 90-hp. turbines is 6 in., and that from the service-pump turbine is 3½ in. The feed-pump turbines have a 6-in. exhaust and a 2-in. steam pipe. The exciter turbine has a 3-in. steam and an 8-in. exhaust pipe.

Water Piping

Under the present arrangement the water in the river is held back by a low mound dam of sufficient height to cause a supply of water to flow to a well from which two

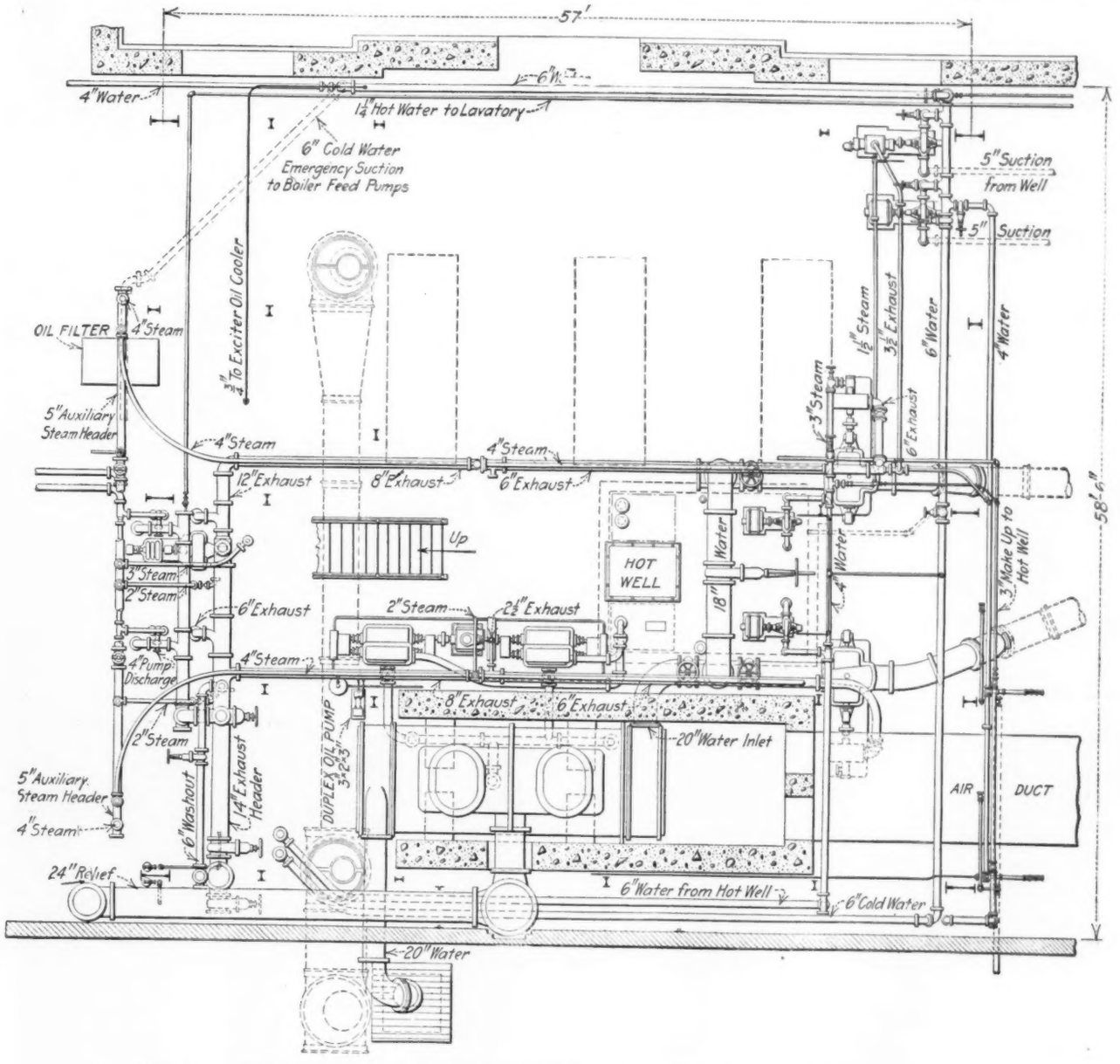


FIG. 11. PLAN OF BASEMENT, SHOWING LIVE STEAM, EXHAUST AND WATER PIPING

24-in. suction pipes lead to the circulating pump. Two 5-in. suction pipes to the service pump are also run from this well. The discharge pipe from the condenser is 20 in. and connects to a main 48-in. line that empties into the river below the dam.

The discharge from the air pumps goes through 5-in. lines to the hotwell, from which it is taken by the hotwell pumps and discharged into the feed-water heater. A 6-in. cold-water line loops the basement, making connection with all of the pumps excepting the circulating units and also supplying water to the feed-water heater in case of emergency.

Electrical Apparatus

To the rear of the building on the main floor, Fig. 13, in brick fireproof compartments, are two 5000-kv.-a., oil-cooled, three-phase, 60-cycle, 6300/45,000-volt, Y-connected transformers. They are provided with trucks which rest on tracks on which they may be run out of the compartments, handy for the traveling crane to pick up. Metal fireproof curtains drop over the entrance to the compartments. There are three 75-kv.-a., 6600/440-volt station transformers for motors in the third compartment, also a 20-kw. transformer and voltage regulator for lighting. A gallery above the transformers is devoted to switchboard, 6600-volt switches and busbars. All high-tension, remote-control oil switches are controlled from a benchboard. Station lighting and exciter control are handled by a separate board. The station is

equipped with the most modern recording and indicating electrical apparatus. Energy for operating the oil switches is obtained from the station exciting units, which can also be used for station lighting in case the main unit is not in operation. Emergency lighting is obtained from a small 8-hp. turbine directly connected to a 5-kw., 125-volt generator. This unit is situated on the switchboard gallery at the front, over the bay containing the station transformers, Fig. 13. It is also used for operating the oil switches in emergencies.

Oil switches are in concrete compartments at the rear of the benchboard. Overhead are the busbars supported by a pipe framework, Fig. 14, making them attractive in appearance and easy of access for making changes should any be necessary, as well as eliminating to a great extent danger of accidental contact on the part of the attendants. Provision has been made for installing additional switching equipment when a second generator is installed. The 45,000-volt busbars and oil switches are in a separate room immediately behind the transformers,

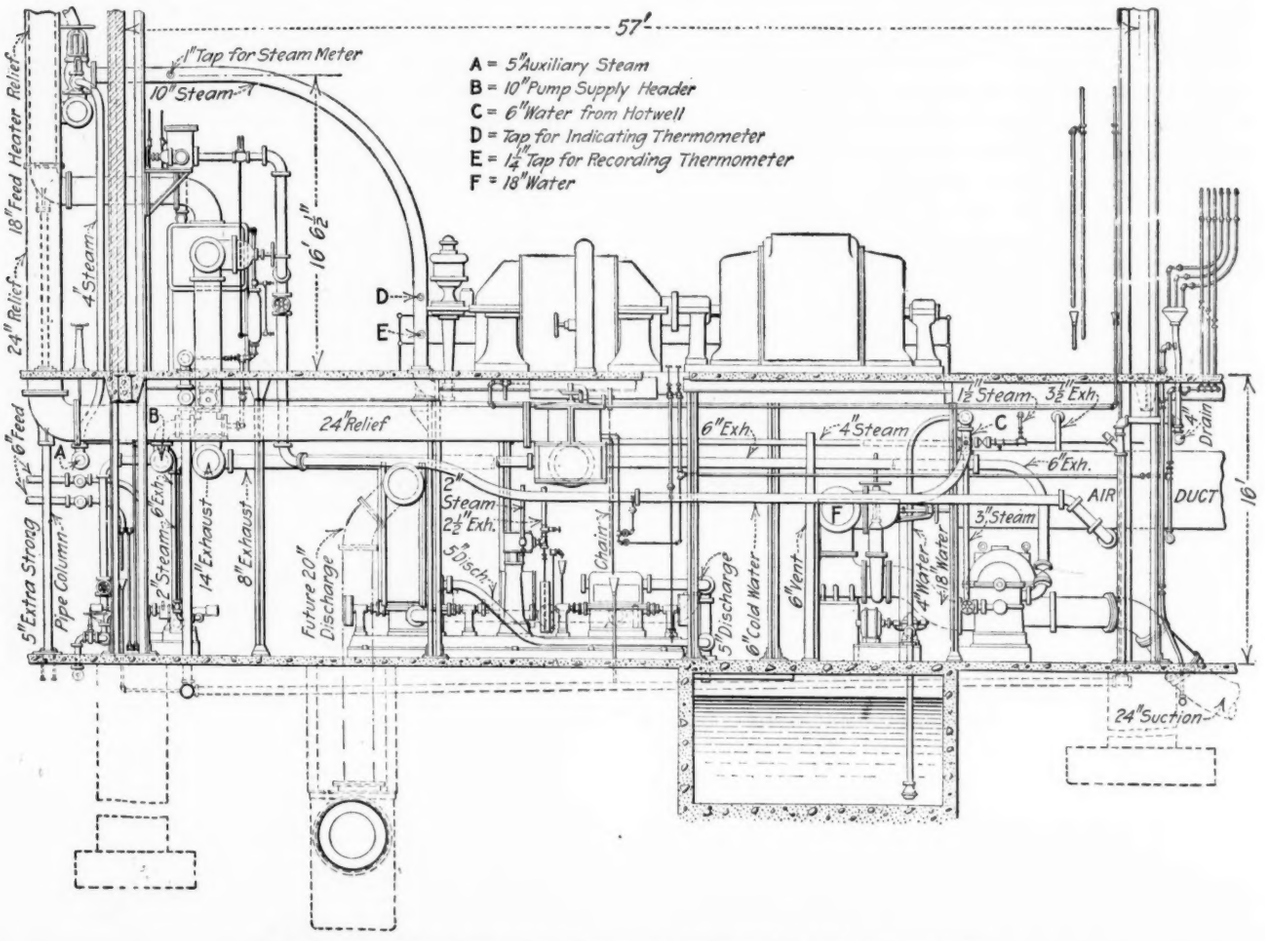


FIG. 12. ELEVATION OF PIPING IN TURBINE ROOM BASEMENT

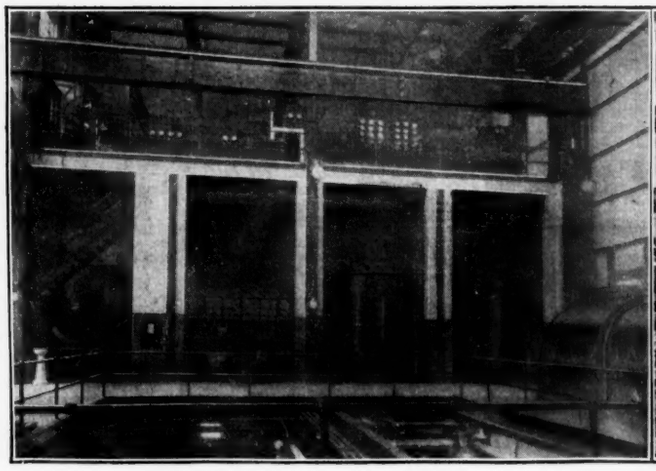


FIG. 13. TRANSFORMER AND SWITCHBOARD BAYS

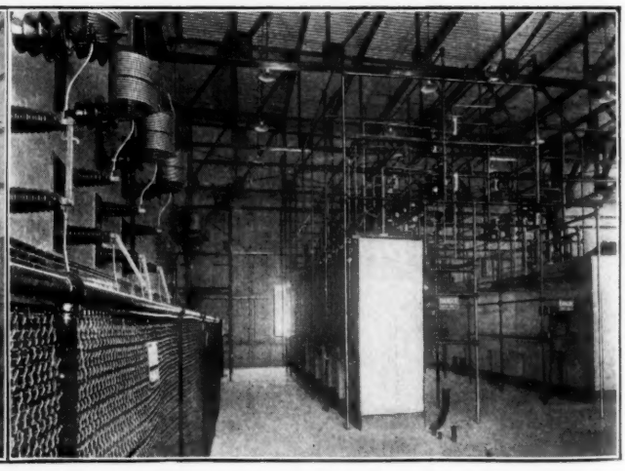


FIG. 14. SHOWING THE BUSBAR CONSTRUCTION

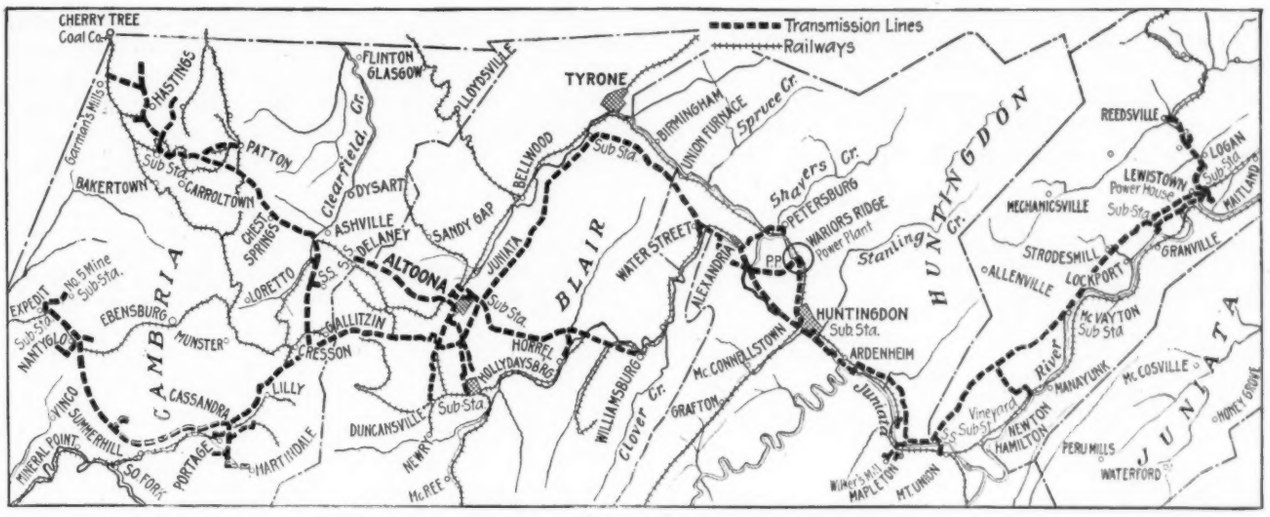


FIG. 15. MAP OF TRANSMISSION LINES, SHOWING SUBSTATIONS AND LOCATION OF THE WARRIOR RIDGE AND WILLIAMSBURG POWER PLANTS

and the 45,000-volt lines pass up the rear walls and out through the roof with the disconnecting switches at the switchboard floor, handy for the operator. The choke coils are inside of the station, as shown, but the 45,000-volt electrolytic lighting arresters are in a room on the roof.

At present the switchboard is wired for two 45,000-volt lines and one 6600-volt line. The 6600-volt line runs to the works of the Standard Powder Co., about five miles from the plant. A 45,000-volt line goes to the distributing station at Altoona, where the two 45,000-volt lines from Warrior Ridge also terminate. From this point electrical energy is distributed to Altoona and to the coal mines in Cambria County. Fig. 15 is a map of the transmission lines, showing the location of the substations and the Warrior Ridge plant with which the Williamsburg plant is tied in. The total length of 45,000-volt transmission lines is 250 miles.

Miscellaneous

The chief engineer is provided with an office on the switchboard balcony. In the basement is a storeroom for

PRINCIPAL EQUIPMENT OF THE WILLIAMSBURG STEAM-TURBINE POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Water-tube	8165 sq.ft. heating surface	Steam generators	175 lb. pressure, stoker-fired, natural draft	Edge Moor Iron Works
3	Superheaters	Foster	Cap. 24,500 lb. steam per hr., 140 deg. rise	Superheating boiler steam	Temperature rise 140 deg. F	Power Specialty Co.
6	Stokers	Wetzel	62 sq.ft. heating surface	Boiler furnaces	Two to each boiler, engine-driven	Wetzel Mechanical Stoker Co.
1	Scale	Traveling-hopper	2-ton	Coal from bunker to stokers	Electric drive	R. H. Beaumont Co.
1	Bunker	Overhead, steel	312 tons, capacity	Bunker coal		R. H. Beaumont Co.
3	Blowers	Vulcan soot		Cleaning boiler tubes	Steam, intermittent	Vulcan Soot Cleaner Co.
1	Pyrometer	Electric		For furnace and flue temp.	Recording	Thwing Instrument Co.
1	Regulator	Mason		Draft control	Automatic	Mason Regulator Co.
1	Chimney	Steel, brick lined	12 ft. dia., 225 ft. high	Furnace gas	Self-contained, natural draft	
1	Conveying system	Belt, bucket and scraper	40 tons per hr	Handling coal	Electrically driven, intermittent	R. H. Beaumont Co.
1	Turbo-generator	Horizontal	5000-kv.a., 4800-kw	Main unit	175 lb. steam, three-phase, 60-cycle 6600 volts, 3600 r.p.m.	Westinghouse Cos.
3	Meters	Bloncк, efficiency				W. A. Bloncк
1	Air washer		26,000 cu.ft. air per min.	Air for generator	Continuous	Carrier Air Conditioning Company
1	Pump	Centrifugal, single-stage	2½-in.	Water for air washer	Motor-driven, 800 r.p.m.	Buffalo Forge Co.
1	Motor	Induction	7-hp.	Driving 2½-in. pump	440 volts, three-phase, 60-cycle, 800 r.p.m.	General Electric Co.
1	Heater	Metering, Cochrane	200,000 lb. water per hr.	Boiler-feed water	Uses auxiliary exhaust steam	Harrison Safety Boiler Works
1	Generator	Direct-current	50-kw.	Exciter	125 volts, 1200 r.p.m.	Crocker-Wheeler Co.
1	Motor	Induction	75-hp.	Driving d.c. generator	440 volts, three-phase, 60-cycle, 1200 r.p.m.	Crocker-Wheeler Co.
1	Generator	Direct-current	50-kw.	Exciter	125 volts, 3000 r.p.m.	Westinghouse Electric & Mfg. Co.
1	Turbine	Two-stage	50-kw.	Driving d.c. generator	175 lb. steam, 3000 r.p.m.	Westinghouse Machine Co.
2	Pumps	Three-stage, centrifugal	3-in., 250 gal. per min.	Boiler feed	Turbine-driven, 2900 r.p.m.	DeLaval Steam Turbine Co.
2	Turbines	Single-stage		Driving boiler-feed pumps	175 lb. steam, 2900 r.p.m.	DeLaval Steam Turbine Co.
1	Condenser	Surface	10,000 sq.ft. cooling surface	With main turbine	28-in. vacuum	C. H. Wheeler Mfg. Co.
2	Pumps	Air, rotrex	18x36-in.	With condenser	Engine-driven, 225 r.p.m.	C. H. Wheeler Mfg. Co.
1	Engine	Vertical	8x7-in.	Driving air pumps	225 r.p.m.	C. H. Wheeler Mfg. Co.
2	Pumps	Centrifugal	18-in., 7000 gal. per min.	Circulating water	Turbine-driven, 1650 r.p.m.	C. H. Wheeler Mfg. Co.
2	Turbines	Terry	90-hp.	Driving circulating pump	1650 r.p.m., 175 lb. steam	Terry Steam Turbine Co.
2	Pumps	Single-stage, cen.	3-in.	Hotwell, 250 gal. cap. per min.	Motor-driven, 1800 r.p.m.	Buffalo Steam Pump Co.
2	Motors	Induction	5-hp.	Driving hotwell pump	440-volt, three-phase, 60-cycle, 1800 r.p.m.	Western Electric Co.
2	Pumps	Single-stage	4-in.	House-service	As required, 1800 and 2000 r.p.m.	Buffalo Forge Co.
1	Turbine	Spiro	20-hp.	Driving 4-in. pump	175 lb. steam, 2000 r.p.m.	Buffalo Forge Co.
1	Motor	Induction	20-hp.	Driving 4-in. pump	440-volt, three-phase, 60-cycle, 1800 r.p.m.	Western Electric Co.
1	Turbine	Spiro	8-hp.	Driving emergency generator	175 lb. steam, 3600 r.p.m.	Buffalo Forge Co.
1	Generator	Direct-current	5-kw.	Emergency lighting	125 volts, 3600 r.p.m.	Crocker-Wheeler Co.
2	Transformers	Oil-cooled	5000-kv.a.	Transforming electrical energy	6600-45,000 volts, 3-phase, 60 cycles	General Electric Co.
3	Transformers		75-kw.	Station service	6600-440 volts	General Electric Co.
1	Filter	Oil		Filtering oil		S. F. Bowser & Co.
1	Pump	Duplex	3x2x3-in.	Oiling system	Steam-driven	Warren Steam Pump Co.
	Switchboard and miscellaneous electrical apparatus					Westinghouse Elec. & Mfg. Co.

plant supplies, with provision for keeping accurate account of all supplies used and their cost. Separate toilet and locker rooms are provided for the fireroom force and for the engineers. The interior of the plant is attractively painted and natural light and ventilation are afforded by the numerous windows. The various units have been arranged with plenty of room about them so that repairs may be made without difficulty in handling parts.

Day & Zimmerman, engineers, of Philadelphia, designed and supervised the erection of the plant, which was constructed under the direction of Frank B. Stem, to whom the writer is indebted for data and drawings.

Gain By Use of Spray Nozzles

SYNOPSIS—At an expenditure of $700 for a spraying system the vacuum in a plant using 1,200 gallons of cooling water per minute was increased from 22.5 to 27.5 in. in the middle of August in Mississippi.

The Laurel Light & Railway Co., Laurel, Miss., has a power plant which utilized a pond excavated in a low spot near the plant for cooling its condensing water, by building a wooden trough down the center of the pond, as shown in Fig. 1, so as to deliver the hot water from the condensers to the end of the pond farthest from the plant, the suction well being located at the end of the

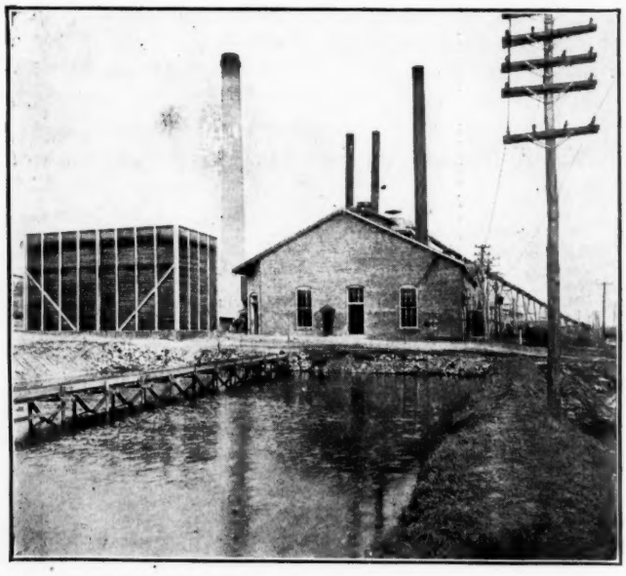


FIG. 1. LOOKING TOWARD THE STATION, SHOWING WOODEN TROUGH IN CENTER OF POND

pond nearest the plant, thus attempting to utilize to the best advantage the surface of the pond as a cooling medium. This proved to be all right when the plant was small and during the winter time, but during the long hot summers in Mississippi the temperature of the pond rose to such a degree that the vacuum was very poor, averaging below 20 in. Then a cooling tower, visible also in Fig. 1, of the open wooden-grill type, was built surrounded by a louver to prevent excessive loss from drift. This helped the situation for a while, but not over 22.5 in. vacuum, based on a 30-in. barometer, could be obtained by the use of the tower. The company finally decided to put in a spray cooling system, the main pipe line of which was installed in the trough over the pond, as shown in Fig. 2, avoiding any further expense for supporting the spray system. As a result the vacuum immediately increased from 22.5 to 27.5 in. in the middle of August during the hottest weather of the year.

This spray cooling system consists of thirty 2-in. bronze turbine spray nozzles arranged in 6 groups of 5 nozzles each by means of special spray heads and arms. These 30 nozzles have a total capacity of 1,200 gal. per min. when

FIG. 2. LOOKING AWAY FROM THE STATION, SHOWING SPRAY NOZZLES SUPPORTED BY WOODEN TROUGH

operating at a pressure of 7 lb. per sq.in. at the nozzle. The size of the pond is 50 by 115 ft. The cost of the entire system, including nozzles, special equipment, piping, fittings, etc., was, in round figures, $700, the only expense in addition to this being the labor of assembling the piping and other equipment in the trough, which already extended down the center of the pond.

Safety in Workshops and factories has been made the subject of a new order to employers issued by the Wisconsin State Industrial Commission, supplementing the original 1912 code of safety orders. The new orders are based on the experience of employers since that time, as collected by the commission's deputies. The first code consisted of 25 general orders covering the chief points of danger on belts, gears, saws, setscrews, etc., and these are permitted to stand, with the exception of order No. 18, covering shafting, which now reads, "All transmission shafting located in places of employment, where exposed to contact, must be guarded." The original order required only that shafting less than 6½ ft. from the floor should be guarded.—"American Machinist."

Storing Steam at the Engine instead of at the boiler was accomplished by placing large receivers and separators near the throttles of reciprocating engines recently installed in the power house of a Western mining company. At the same time the boiler drums installed at the plant were made unusually small, as the company's engineer declared that the proper place to store steam is at the engine throttle and not in the boilers. The receiver capacity at each engine is practically four times the cylinder capacity, and this steam reservoir permits the use of smaller steam piping, thereby reducing heat losses and establishing at the same time a reserve supply of dry steam immediately at the engine throttle, where it is most needed under the condition of an engine engaged in mine hoisting.—"Electrical World."

Notes on Overhauling the Refrigeration Plant--I

By F. E. Matthews

SYNOPSIS—Functions of the various parts of a refrigerating machine defined. Effects of foreign substances on the transmission of heat through expansion coils and condenser surfaces. The separation of oil from ammonia and its removal from expansion coils.

The compressor is a pump for transferring the ammonia from the refrigerator to the condenser—from the place where it absorbs heat by being at a lower temperature than the surrounding air to where it can allow heat to escape by being at a higher temperature than the surrounding cooling water.

Attention to Lubricating Oil

The chief function of the heat-transmitting surfaces, both of the expansion and the condenser piping, which are simply suitable containers in which to expose liquid and gaseous ammonia to the respective heating and cooling effects of the surrounding media, is to provide for the easiest possible ingress and egress of heat. No other substance than the metal of the pipe itself should intervene between the heating and the heated fluids. Expansion-pipe surfaces may be compared to boiler-tube surfaces and ammonia-condenser surfaces to steam-condenser surfaces, the transmission of heat through all of which is subject to the same limitations. The disadvantage will be in proportion to the efficiency of the substance as an insulator. The same scrupulous care should be exercised in preventing the accumulation of oil on expansion coils as on boiler plates.

Since oil performs useful functions only in the compressor, every possible means should be adopted for restricting it to that part of the system. To do this involves several factors, not the least of which is the suitability of the oil to the work required of it. The engineer should purchase a standard article from a reliable company known to deal largely in oils especially prepared for ice-machine use. This need be departed from only where exceptional temperatures are encountered. Because of the low temperatures at which the refrigerant sometimes returns to the compressor, only comparatively light oils can be employed. Under the high temperatures resulting from the compression of the ammonia when it happens to return to the compressor in a superheated condition, this oil is likely to become volatilized and pass over to the condenser with the gas. On account of the high velocity and comparatively slight difference in density between the discharged ammonia gas and the vaporized oil, it is difficult to effect a complete separation by existing means, even though the velocity is slightly reduced in traversing the oil separator. If the ammonia could be subjected to a considerable cooling effect before entering the separator and the direction of travel be more frequently and abruptly reversed, even the slight difference in density of the two substances might suffice for their separation.

As oil separators are now constructed, the engineer can only do his best to reduce the evil to a minimum by so operating the compressor that excess temperatures, producing rapid vaporization of the oil, will not be generated during compression. The oil trap should be drained at frequent intervals to insure against entrainment of the liquid lying in the bottom, by the impingement of the gas passing through the usually too small oil-trap sections at too high a velocity. The liquid tank should likewise be frequently drained of oil that may have found its way through the condenser. Even when all of these precautions have been taken, sometimes oil will find its way to the expansion valve.

The most logical way of preventing oil from entering the expansion coils is by the use of a device which separates the oil by refrigerating it, but which for some unexplainable reason has never come into general use. In such a device the liquid ammonia containing traces of oil occupies, just before passing the expansion valve, a chamber of sufficient capacity to insure against its being obstructed by the congealed oil, and is subjected to the full refrigerating effect of the expanding refrigerant.

Oil in the Expansion Coils

A comparatively small percentage of the oil entering the expansion coils will eventually find its way back to the compressor in company with the returning gas, the amount depending on the number of "shutdowns" allowing the temperatures to rise in the coils and the oil to become softened, the frequency of "pumping back," which produces more violent ebullition of the ammonia, tending to dislodge the oil, and in fact any irregularity in the operation of the plant tending to disturb the balance of conditions that hold the oil in a frozen condition on the surface of the coils.

There are on the market several types of ammonia purifiers by which moisture and oil are extracted from the returning gaseous refrigerant. The chief virtue of these purifiers is that they do a little good all the time.

When the expansion coils have become coated with oil, which may occur in a few hours of careless operation, advantage should be taken of the winter shutdown to give them a thorough cleaning. If this has not been done for two or three years, it is safe to assume that the coils are in condition to warrant it. The methods employed must be modified to suit the form and condition of the coils. If they are so constructed that a flange joint can be opened at the lowest point, allowing the coil to be blown out first by steam and then by air, without liability of trapping condensed moisture, the problem is comparatively simple. If, on the other hand, the coil is of the continuous-welded trombone type with the bottom pipe returned to the top, as is frequently the case, it will have to be disconnected, removed and placed in such a position that the condensed moisture will drain out when steam is applied. The danger from trapped condensation cannot be over-estimated. The simple application of steam, even under high pressure, will not neces-

sarily free the coil from all the oil or from the moisture due to its own condensation.

Condensation can be prevented only if the coil is maintained at a temperature equal to that of the incoming saturated steam; or if superheated steam is used, at a temperature at which it will be reduced only to saturation by the time it leaves the coil. As superheated steam or means of effectively heating the coils are not usually at hand, compressed air which, since it does not condense, travels with uniform velocity through the length of the coil, is usually employed to free the coil from moisture. The drying effect of this air can be readily increased by passing it through some form of heater immediately after it passes the valve controlling its flow to the coil. If cooling of the air heated by compression is allowed to take place, or what is worse, intentionally produced in some form of cooler, it is evident that the refrigerating effect produced by the air on expanding as its pressure is reduced on entering the coil may be sufficient to reduce its own temperature to a point at which it will be saturated with the moisture that it already contains and cannot, in consequence, absorb any of the moisture resulting from condensation. High velocity, coupled with reasonably high temperature, is essential to the effective dislodgment of oil. The steam should be allowed to flow through the coil as long as any trace of oil can be found.

In some types of ice-freezing and brine-cooling tanks the lower pipes of the coils extend through the side of the tank near the bottom, where they are connected to a header. In such cases disconnecting the headers at the top and bottom suffices to put the coils in condition to be blown out. If the brine is allowed to remain in the tank it should be heated; otherwise the steam will condense almost as soon as it enters the coil and there will be neither sufficient heat in the steam to make the oil fluid nor velocity to dislodge it.

If the tanks have been in operation for a considerable time, the outside surfaces will probably be coated with rust and other foreign matter. This should be removed with scrupulous care. To do this most effectively the brine should be removed from the tank. The coils would then be dried by the heat of the steam used in blowing out the oil, so that the deposit could be brushed off in the form of dust. All foreign matter should be removed from the tank, as the agitation of the brine may otherwise again deposit it on the coils. The occasion for cleanliness in the expansion coils is obvious when it is remembered that the difference in temperature between the brine and the evaporating refrigerant is slight as compared to that between the products of combustion and the water evaporating in a steam boiler, and furthermore that the efficiency of the plant is in direct proportion to the absolute evaporating pressure in the coils, which is materially lowered by any insulating deposits tending to retard the flow of heat through the surfaces.

Visits of Inspector Brown--VIII

By J. E. Terman

SYNOPSIS—An engineer gets the best of an argument regarding the force exerted tending to blow off an outside patch, and when Brown appeals to the Chief for information, the problem is graphically explained.

"Chief," said Brown one day, "I've come to you again regarding the strength of boiler patches. I got in an argument today with the engineer at the water-works plant and although you say properly fitted patches do not tend to blow off when riveted to the outside of the shell, I could not convince the engineer on that point. I guess there are some things regarding stresses in boiler shells, due to internal pressure, that I have not caught yet.

"I found that a girth seam on No. 3 boiler had developed so many fire cracks that I ordered a long patch, semielliptical in shape, put on. I told the engineer that the patch could not be placed on the inside in this case, and he wanted to know why.

"I explained that as the patch formed a portion of an inner course of the shell, it would have to be placed on the outside of the boiler in order to fit properly at the girth seam. The engineer saw the point and was satisfied, but I did not let well enough alone and I told him that it would not make any particular difference in the strength of the patch, whether it was fitted to the inside or the outside of the shell, and then the argument started.

"I tried to show the engineer," continued Brown, "that there was no tensile stress on the rivets that held on a patch placed on the outside of a shell except the stress set up by the shrinkage of the rivets when driven, and which was necessary to hold the plates together to permit calking so as to make a tight joint. I tried to convince him that I was right by asking if he thought there was shearing stress in any portion of the solid shell plate preventing a tendency to blow out a section, and if the solid part of the shell of a boiler was not subjected to a tensile stress only.

"This question seemed to feaze him some at first, but he said that he was not sure but that if you considered

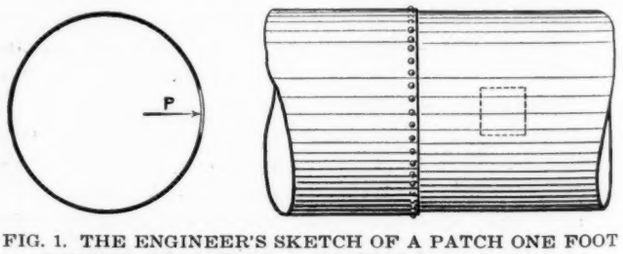


FIG. 1. THE ENGINEER'S SKETCH OF A PATCH ONE FOOT SQUARE SUSTAINING A PRESSURE OF 14,400 LB.

a small section of the shell of a boiler like this (Fig. 1) there was a tendency to blow it out. The engineer said that the pressure P inside the boiler certainly acted on the section considered and that if the size of the section was 1 ft. square and the pressure in the boiler was 100 lb. he thought there would be 14,400 lb. on the section tending to shear the metal all around the sides and blow out the piece.

"I feel that there is a bug in my argument somewhere, but I can't tell what is wrong, and as the matter now

stands the engineer has the laugh on me and I have got to make good."

"Well, Brown, one way to have answered that engineer would have been to ask him to extend the dimensions of the portion of the shell that he selected so as to take in half the circumference, like this," said the Chief, drawing Fig. 2. "I think he would admit that all of the pressure on the shell from A to A, in this case, is carried on the sides AA, and that the metal along the circumferential lines BB need not be taken into consideration."

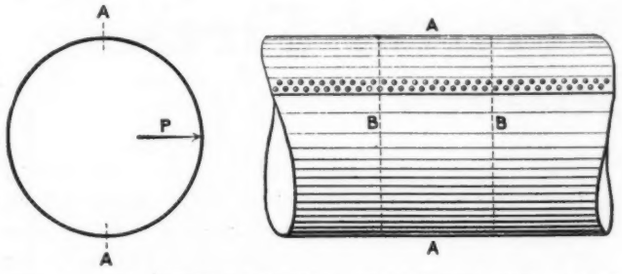


FIG. 2. THE CHIEF'S SKETCH, EXTENDING THE PATCH TO ONE-HALF THE CIRCUMFERENCE

"That is just what I did," replied Brown, "and the engineer claimed that was a different proposition, and that my argument did not apply when a smaller section than a semicircle was used."

"Well, you might have asked him just where the change took place, for there was where he was wrong. Action and reaction are always equal, no matter whether the reaction is made up of inertia, friction, useful work or what not. The statement that a cylinder, when subjected to internal pressure, tends to retain its cylindrical form and increase in diameter is as old as the hills and is still true. Did the engineer say whether it made any difference as to the diameter of the shell?"

"Well, I asked him that question," replied Brown, "and he said that he thought that it would make no particular difference as long as the pressure was the same."

"That is where he was badly wrong again, as I will presently show you. If you consider a small section of the shell, as did the engineer, the stresses may be represented as in Fig. 3. We will take the straight distance across the portion of the shell selected as 12 in. and the internal pressure at 100 lb. to make the problem like the one the engineer proposed. Now, the force tending to blow this off is, as the engineer stated, 14,400 lb., and what we have to do is to find out what resists this 14,400 lb. and see if it can produce a shearing stress in the shell plate.

"You are familiar with the triangle of forces and know that if three concurring forces are in equilibrium they may be represented in intensity and direction by the sides of a triangle drawn parallel, respectively, to the direction of the forces. We know that the forces due to internal pressure, acting on the shell of a boiler, must be in equilibrium, for they do not tend to move the shell in any direction unless something gives way.

"We will assume that in Fig. 3 the circle represents the shell of a boiler, that from F to I the distance is 12 in., and that lengthways of the shell, at F and I, there are rows of rivets holding on a patch. Now, the pull on the shell due to the internal pressure tending to rupture it at F and I will act along the lines FG and IG, these lines being drawn tangent to the shell at F and I. The force tending to blow out the section of the shell between F and I will act in the direction of HG, directly away from the center. Since the forces at F and I are in equilibrium, they may be represented by the sides of the triangles $FGHF$ and $IGHI$, and since the angles of triangle $FGHF$ are equal to the angles of triangle $OFHO$, these two triangles are similar and therefore their sides are proportional to each other. Lettering the sides of the triangles A, B, C and R for the sake of simplifying matters, we have $A:B::R:C$, or $AC = BR$.

"Now, we have assumed that FI is 12 in., therefore C would be 6 in., and we will assume that R is 30 in. This is where the diameter of the boiler comes into the problem, for then from our formula we have $6A = 30B$, or $A = 5B$. Where R equals 30 in. A will equal the pressure times the radius times the length of the shell considered, or $100 \times 30 \times 12$, or 36,000 lb., if the length of the plate considered is 12 in. This, substituted in our formula, gives $36{,}000 = 5B$, or $B = 7200$ lb. But this represents only one-half the force acting in the direction HG, because the force GI also has to be opposed by a force equal to B; therefore, the total force acting along HB to produce equilibrium at F and I is $2 \times 7{,}200$, or 14,400 lb. Since the patch considered was 12x12 in., the force tending to blow it off due to a pressure of 100 lb. was $12 \times 12 \times 100 = 14{,}400$ lb., as stated before.

"You see, Brown," said the chief, "that all the tendency for a patch to be blown off is counteracted by the tangential pull at F and I and that rivets along these lines would be subjected to a shearing stress only, produced by the direct tensile stress in the shell due to internal pressure. The same proportion, that is, $AC = BR$, holds good for any angle; for example, when a semicircle is reached, C becomes equal to R and they cancel out of the equation, leaving $A = B$, and as B represents one-half the force tending to blow off the section considered, we have the old familiar formula giving the tensile stress in the shell of a boiler due to internal pressure—radius times pressure times length of shell considered equals stress. The fact that A and B become infinite in length when they become equal to each other does not make any difference, for you will remember we have been taking the value of A in pounds as the product of the radius times the pressure times the length of the shell section considered, regardless of the position of A, and the value of B was the one that changed with the increase

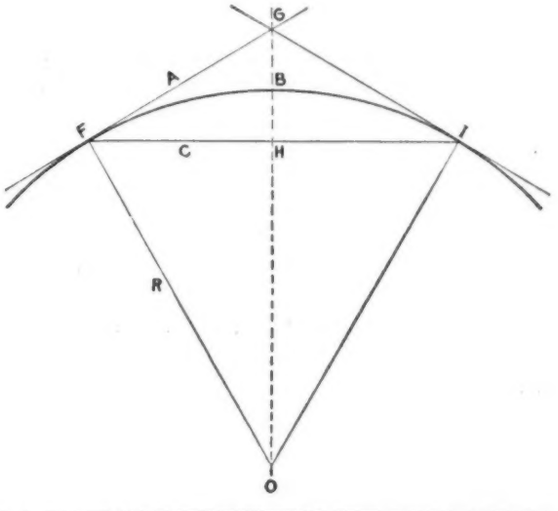


FIG. 3. DIAGRAM REPRESENTING THE BOILER STRESSES

in girth-wise width of the section considered, and when it reached an infinite length, it reached its maximum value —equality with *A*.

"Well," said Brown, "I feel sure that I can now go back to the water-works plant and land a solar plexus on that engineer."

"That problem was a little out of line for an engineer," replied the Chief, "but it would not be out of place for a few of the inspectors in this office to brush up on such questions. It is an easy matter to get an idea and stick to it without taking the trouble to find out whether it is right or wrong."

Superheat in Vertical Fire-Tube Boilers

By Stanley P. Stewart

SYNOPSIS—Factors governing superheat. How load, water level and furnace conditions affect the quality of the steam generated in this type of boiler.

The ordinary vertical fire-tube boiler, not of submerged tube-head construction, is the only type in which there is direct heating surface in the steam space above the water line. In all other types water only is in contact with the heating surfaces and in order to superheat the steam from these boilers it is necessary to install a superheater. [Except where gases are carried up across the steam drums.—Editor.]

Just what effect this heating surface in the steam space of a vertical fire-tube boiler has on the quality of the steam has been the subject of debate. It is held by some that in this type of boiler there is insufficient heating area and too close contact of the steam with the water from which it is produced to have any appreciable amount of superheat. On the other hand, it is reasonable to suppose that the heating surface above the water line should be great enough to heat the steam considerably above the temperature of saturation. That this supposition is correct has been proved many times in tests for boiler efficiency, but not to the writer's knowledge have any consistent tests been carried on to determine the factors that influence superheat in the vertical fire-tube boiler.

Since the degree of superheat produced by a superheater placed within the boiler setting will vary according to the class of fuel used, the form of furnace, the condition of the fire, the efficiency of the heating surfaces and the rate at which the boiler is being operated, it should be supposed that the superheat in the vertical fire-tube type would be dependent upon these same conditions and, further, upon the distance of the water line from the top head.

It was for these reasons that the writer investigated the conditions affecting the steam generation of this type of boiler. The tests were conducted on one boiler of a battery of two, which had the following dimensions:

Diameter of boiler	84⅞ in. outside
Length over all	20 ft. 9 in.
Number of tubes	256
Diameter of tubes	2½ in.
Length of tubes	15 ft.
Diameter of firebox, inside	78 in.
Height of firebox above grates	60 in.
Total heating surface	2420 sq.ft.
Water-heating surface	1795 sq.ft.
Nominal superheating surface	625 sq.ft.
Horsepower at 1 hp. per 12 sq.ft. of heating surface	201
Grate area	33.25 sq.ft.
Disengagement area at water line	30.56 sq.ft.
Heating surface per 1 in. vert. of tubes	12.76 sq.ft.
Manufacturer	Stewart Boiler Works, Worcester, Mass.
Location	Worcester Polytechnic Institute, Worcester, Mass.

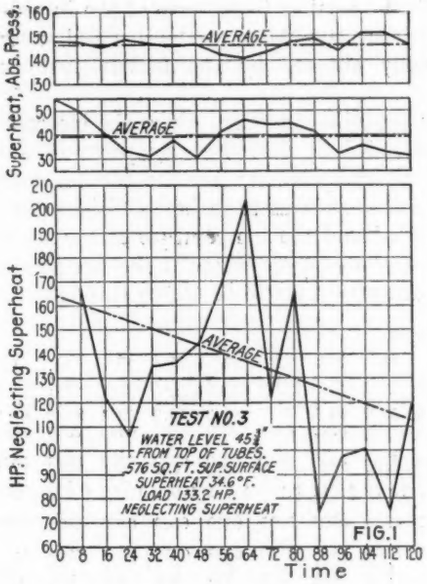
The boiler was equipped with a safety water column, shaking grates and a steam jet blower. The fuel burned was a mixture of bird's-eye and Bulah. The boiler was fed by a steam pump through a closed heater. The load was varied by adjusting the valve on the steam blower and by regulating the damper on this boiler so that all loads from zero to overload could be obtained as desired by proportioning the burden between this boiler and the other of the battery. The load was measured by readings on a Union water meter, which was calibrated by weighing and which was located so that only the water passing to this boiler was measured. The water level was kept practically constant by carefully watching and operating the steam-feed pump and by regulating a bypass feed valve to the other boiler.

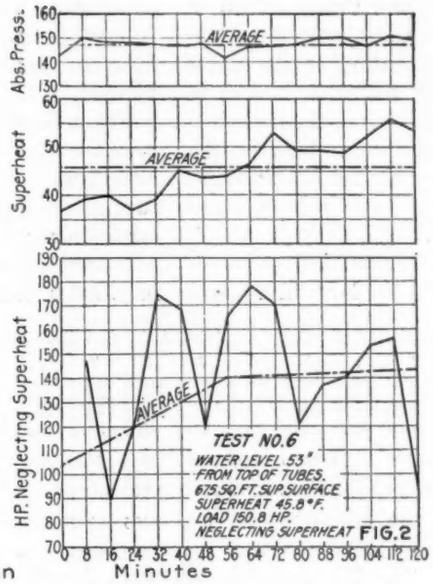
The temperature of the steam was found by inserting a carefully tested thermometer in an oil well on the steam pipe at the outlet of the boiler. The pressure was determined by a calibrated steam gage connected to the steam pipe close beside the thermometer well. All gage readings were reduced to absolute pressure according to the barometer readings at each test. The same thermometers, gages and other apparatus were used in all the tests, so that the results are directly comparable. It was necessary to assume that the feed temperature was constant at 185 deg. F. throughout these tests, as this was what the average temperature was found to be under the same conditions on previous tests.

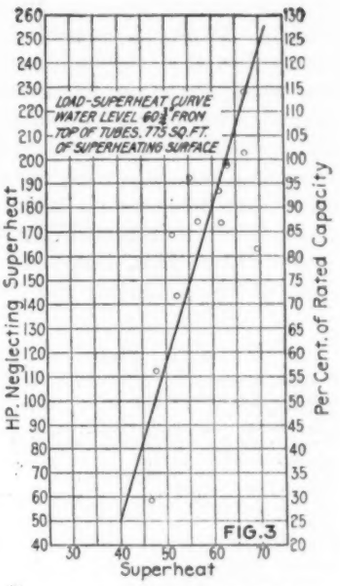
All firing operations were recorded when running the test and the effect on steam conditions noted. Tests were run from one-half hour to two hours, readings being taken every two minutes. The water level was allowed to become constant before starting and kept as nearly constant as possible.

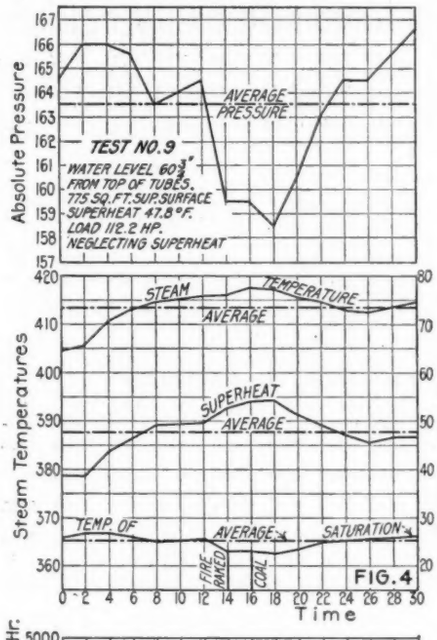
The first series of tests were run to observe the effect of load on superheat, the water level being kept constant. Figs. 1 and 2 show graphically the results of two tests, each of two hours' duration at two different water levels. The lower solid lines show the rate of feed converted into equivalent load, neglecting superheat, and the lower dotted line shows the general average load throughout the test.

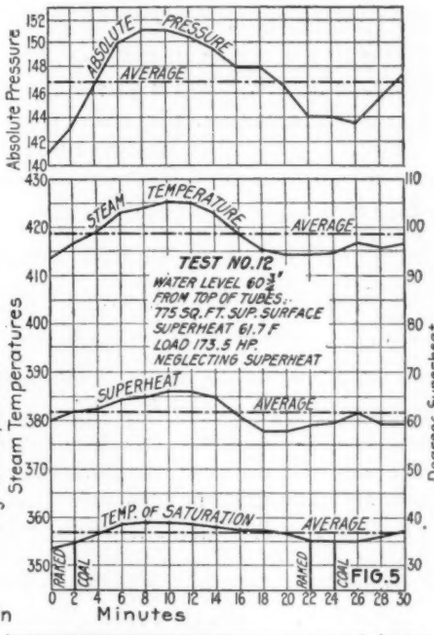
To have the standard of comparison for all variable conditions, the load is calculated and expressed in the usual terms of equivalent evaporation from and at 212 deg., assuming the steam dry-saturated. It will be seen that in both cases the superheat varies directly as the load. Each increase in load has a distinct and immediate increase in superheat and *vice versa*, and the general average increase and decrease of superheat with average load are clearly shown.

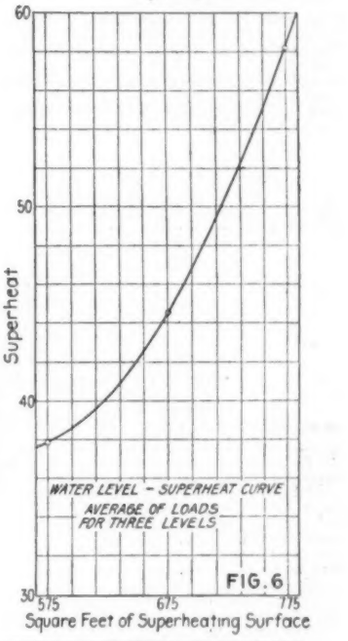


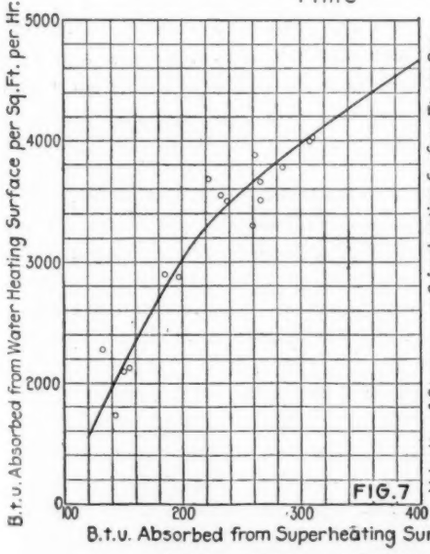


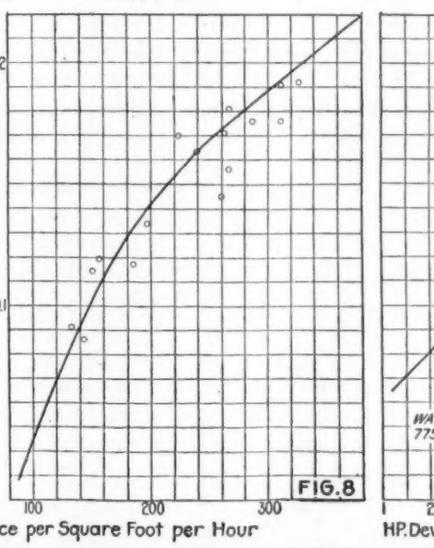

LOAD-SUPERHEAT CURVE
WATER LEVEL 60½" FROM TOP OF TUBES. 775 SQ.FT. OF SUPERHEATING SURFACE
HP. Neglecting Superheat
Per Cent. of Rated Capacity
FIG.3
Superheat

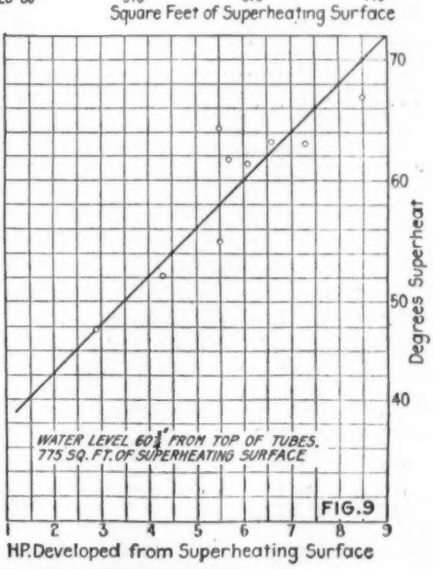







B.t.u. Absorbed from Water Heating Surface per Sq.Ft. per Hr.
FIG.7
B.t.u. Absorbed from Superheating Surface per Square Foot per Hour




WATER LEVEL 60½" FROM TOP OF TUBES.
775 SQ.FT. OF SUPERHEATING SURFACE
FIG.9
Degrees Superheat
HP. Developed from Superheating Surface

FIGS. 1 TO 9. CURVES OF SUPERHEAT TESTS ON VERTICAL FIRE-TUBE BOILER

Testing with several loads at one water level gives the general effect of load on superheat, and this is shown in Fig. 3. It would seem that the result should be opposite this, that the increased evaporation at the water line would lower the temperature of the steam nearer to that of saturation; but evidently, in general, the increased flue-gas velocity and temperature difference between the flue gases and the steam, together with the better firing conditions necessary to maintain a greater load, more than offset this increased ebullition.

A study of Figs. 4 and 5, showing graphically the results of two half-hour tests, illustrates how firing and furnace conditions, with constant load, affect the steam generated. Of 17 tests thus plotted, 14 were similar to Fig. 4 and 3 similar to Fig. 5, so these curves may be taken as characteristic. It will be observed in Fig. 4 that pressure increase is accompanied by a decrease in superheat and *vice versa*. This can be explained by the furnace condition in which the fire remains good and the flue gases hot, but the steam is drawn from the boiler faster than generated and, consequently, the pressure drops. The temperature of the flue gases is not lessened in proportion to the decrease in pressure if at all, and so the temperature of the steam and the resultant superheat increase. When the loss of pressure is noted by the fireman and the boiler is stoked, the sudden production of saturated steam at the water line temporarily lessens the temperature of the steam and the degree of superheat. This is not similar to the case of the increase in load, because in that case steam production and superheat are continually affected by the factors just explained.

Fig. 5 shows an opposite condition, where the increased pressure is accompanied by increased temperature and superheat. With an exceptionally hot fire the temperature of the flue gases is such as to make conditions similar to increase in load and the temperature of the steam will increase with the pressure. Then, if the fire should have holes which allow cold air to be blown through, the temperatures of the flue gases and steam will drop with the pressure. This is due to poor and spasmodic firing, as indicated by the uneven pressure line. The permutations and combinations of all furnace conditions make it difficult to observe and accurately explain the exact effect of each factor, but the general effects, as shown by long tests and averages, are indisputable.

To show the effect of water level on superheat it was necessary to test for many loads at different water levels, getting the average superheat for all loads at each level. Fig. 6 shows clearly and definitely the results of these tests and the increase of superheat with the decrease in water level.

Table 1 gives the general details of 17 tests, although the load-superheat and water-level-superheat curves were

TABLE 1. GENERAL DATA OF SEVENTEEN TESTS

Number of Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pressure, lb. abs	146.7	146.7	148.3	146.4	147.7	148.7	147.2	148.4	163.5	162.7	147.1	146.9	139.7	147.7	147.5	138.3	136.6
Steam temperature, deg. F	401.7	392.1	392.2	392.2	396.6	403.6	402.8	398.6	413.2	417.1	421.3	418.6	415.2	412.3	420.3	415.2	418.0
Superheat, deg. F	45.0	35.3	34.6	35.6	39.3	45.8	45.8	40.9	47.8	52.2	64.3	61.7	61.3	55.0	63.1	63.0	66.8
Water fed to boiler, lb. per hr.	3060	4080	4280	6300	6500	4840	5875	6140	3602	4598	5220	5560	6000	6155	6345	6360	7324
Water actually evaporated, correcting for superheat, lb.	3140	4175	4380	6435	6655	4965	6030	6300	3698	4735	5420	5760	6220	6355	6575	6615	7622
Temperature of feed, assumed	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
Factor of evaporation	1.072	1.072	1.072	1.072	1.072	1.072	1.072	1.072	1.074	1.074	1.072	1.072	1.071	1.072	1.072	1.071	1.070
Equivalent evaporation from and at 212 deg., neglecting superheat, lb.	3282	4380	4600	6755	6970	5185	6302	6580	3871	4935	5600	5965	6430	6600	6805	6820	7850
Equivalent evaporation from and at 212 deg., correcting for superheat, lb.	3364	4475	4695	6915	7130	5330	6465	6750	3975	5085	5815	6180	6655	6815	7050	7080	8155
Distance of water level below top tube-sheet	45¼	45¼	45¼	45¼	45¼	53	53	53	60¾	60¾	60¾	60¾	60¾	60¾	60¾	60¾	60¾
Superheating surface, sq.ft.	576	576	576	576	576	675	675	675	775	775	775	775	775	775	775	775	775
Horsepower delivered, neglecting superheat	95.40	127.20	133.20	196.20	202.50	150.80	183.1	191.20	112.20	143.20	163.00	173.5	186.90	192.00	197.50	198.50	228.00
Horsepower delivered, correcting for superheat	97.50	129.80	136.00	200.10	206.50	154.5	187.5	195.80	115.00	147.50	168.50	179.2	193.00	197.50	204.10	205.30	236.50
Horsepower per sq.ft. grate surface, correcting for superheat	2.93	3.91	4.08	6.02	6.21	4.65	5.64	5.89	3.46	4.43	5.07	5.38	5.81	5.94	6.14	6.17	7.12
Water-heating surface per hp., correcting for superheat, sq.ft.	18.90	14.20	13.60	9.22	8.93	11.30	9.30	8.90	14.30	11.15	9.76	9.18	8.52	8.32	8.06	8.02	6.95
Total heating surface per hp., correcting for superheat, sq.ft.	24.82	18.62	17.80	12.01	11.72	15.66	12.91	12.36	21.10	16.41	14.37	13.50	12.54	12.25	11.85	11.80	10.23

TABLE 2. DATA FOR LOAD-SUPERHEAT CURVE

Water level 60¾ in. from top of tubes—775 sq.ft. of superheating surface

Horsepower, neglecting superheat	58.6	112.2	143.2	163.0	168.5	173.5	174.3	186.9	192	197.5	198.5	202.5	228.0
Superheat, deg. F	46.8	47.8	52.2	64.3	51.3	61.7	56.6	61.3	55	63.1	63.0	66.8	66.8

TABLE 3. DATA FOR WATER-LEVEL-SUPERHEAT CURVE

Distance of water level from top tube head, in.	45¼	53	60¾
Superheating surface, sq.ft.	576	675	775
Superheat, deg. F	37.9	44.5	58.2

Values of superheat are averages for all loads at given water levels.

TABLE 4. EVAPORATING AND HEAT-ABSORBING CAPACITIES OF WATER AND SUPERHEATING SURFACES

Number of Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Superheating surface, sq.ft.	576	576	576	576	576	675	675	675	775	775	775	775	775	775	775	775	775
Superheat, deg. F	45.0	35.3	34.6	35.6	39.3	45.8	45.8	40.9	47.8	52.2	64.3	61.7	61.3	55.0	63.1	63.0	66.8
Equivalent evaporation from and at 212 deg., neglecting superheat, lb.	3282	4380	4600	6755	6970	5185	6302	6580	3871	4935	5600	5965	6430	6600	6805	6820	7850
Equivalent evaporation from and at 212 deg., correcting for superheat, lb.	3364	4475	4695	6915	7130	5330	6465	6750	3975	5085	5815	6180	6650	6815	7050	7080	8155
Feed water evaporated per sq.ft. water-heating surface per hr., lb.	1.66	2.22	2.33	3.42	3.52	2.78	3.37	3.52	2.19	2.79	3.18	3.38	3.65	3.74	3.85	3.86	4.45
Equivalent evaporation from and at 212 deg. per sq.ft. water-heating surface per hr., neglecting superheat, lb.	1.78	2.38	2.49	3.66	3.78	2.97	3.61	3.77	2.35	3.00	3.40	3.63	3.91	4.01	4.13	4.14	4.77
Equivalent evaporation from and at 212 deg. per sq.ft. total heating surface per hr., neglecting superheat, lb.	1.36	1.81	1.90	2.79	2.88	2.14	2.61	2.72	1.60	2.04	2.31	2.46	2.66	2.73	2.81	2.82	3.24
Amount of superheating in 1 lb. steam, B.t.u.	27.0	21.2	20.8	21.4	23.6	27.5	27.5	24.6	28.7	31.8	38.6	37.1	36.8	33.0	37.8	37.8	40.2
Feed-water consumption of superheat surface, lb. per sq.ft. per hr.	5.32	7.08	7.44	10.92	11.28	7.18	8.70	9.10	4.65	5.93	6.73	7.17	7.75	7.94	8.18	8.20	9.45
Heat transmission to superheat surface, B.t.u per sq.ft. per hr.	143.5	150.0	154.8	233.4	266.0	197.7	239.3	223.8	133.3	185.5	259.7	266.0	285.0	262.0	309.5	310.0	380.0
Heat transmission to water surface, B.t.u. per sq.ft. per hr.	1724	2101	2132	3553	3658	2883	3501	3678	2280	2905	3310	3512	3790	3885	4000	4010	4525
Velocity of steam over superheating surface, ft. per sec.	0.086	0.114	0.119	0.177	0.181	0.131	0.163	0.170	0.091	0 117	0.145	0.156	0.176	0.171	0.176	0.191	0.219

plotted from values obtained in these and 8 additional tests not here tabulated. Table 2 shows the data from which the load-superheat curve in Fig. 3 was plotted, and Table 3 shows the data from which the water-level-superheat curve in Fig. 6 was plotted. Table 4 shows the evaporative and heat-absorption capacities of the water and superheating surfaces. The relation between the B.t.u. absorbed from the water-heating surface and that absorbed from the superheating surface per square foot per hour is graphically shown in Fig. 7. Fig. 8 shows the relation between the velocity of steam over the superheating surface and the B.t.u. absorbed per square foot per hour. Fig. 9 shows the relation between the degrees of superheat and the horsepower developed from the superheating surface. This is taken for one water level.

These results show the general and unmistakable variation of the degree of superheat with change of evaporative duty and water level in the vertical fire-tube boiler and prove that superheat is affected by essentially the same factors in this boiler as in a separate superheater. The degree of superheat produced in a superheater of the same size would be from double to four times greater for two important reasons: First, the steam is further removed from the water from which it is produced and hence would not be subject to the cooling influence of the top of the water and ebullition of saturated steam; second, the velocity of the steam is from 100 to 1000 times greater through the superheater than in the boiler, giving much greater absorption and efficiency of the heating surfaces. While the degree of superheat is not nearly so high as that produced in a superheater, it is sufficiently great to have many advantages over saturated steam.

Experience has proved that a saving of from 10 to 30 per cent. and even more can be obtained from the use of moderately superheated steam, the percentage depending on the conditions of the plant, such as type of engine, length of piping and degree of superheat. It has also been proved that with engines of ordinary design, slide-valve and Corliss, the temperature at the throttle should not exceed 500 deg. F. This corresponds to a superheat of 135 deg. F. at 150 lb. gage pressure. Higher temperatures seriously interfere with packing and lubrication, cause warping of the valves and deterioration of the cast-iron parts; 250 deg. of superheat appears to be the maximum possible to employ without apparatus of a special nature and is seldom, if ever, used in this country.

As seen in these tests, the steam generated in a vertical fire-tube boiler of this size is superheated from 30 to 66 deg. F. What are the effects and advantages in general of this moderate degree of superheat? Table 5 shows a few advantages for each test condition. It will be observed that, owing to superheating the steam, the equivalent evaporation, or horsepower, is increased from 2 to 3.7 per cent. over the same area of water-heating surface in a boiler generating saturated steam. This superheated steam has much lower thermal conductivity than saturated and hence will not lose so many heat units in being delivered. In order to condense superheated steam it must first be reduced to saturation temperature, while any heat lost from saturated steam produces an immediate condensation and a tremendous loss in volume. This causes losses in drips and leaks and possible danger from water-hammer. Also, the loss in pressure in the pipes is less in the case of superheated steam than with saturated, as the specific gravity of the latter is greater than that of dry superheated steam and, consequently, saturated steam is affected more by friction, shocks and bends in the line. The condensation of saturated steam in the pipe line compels the use of drips, separators and traps, the necessity for which the use of superheated steam practically obviates, lessening the cost of the pipe line and decreasing maintenance expenses.

As the temperature of steam is raised its specific volume increases directly as the temperature, or approximately 8 per cent. for each 50 deg. F. of superheat. This makes the weight of steam per horsepower in the engine cylinder proportionately less and also means, in the case of condensing engines, that less water need be circulated in the condenser, with less pump power necessary, the smaller weight of superheated steam more than compensating for any increased temperature. In fact, there is far more than this proportional increase in expansive capacity, owing to the decrease of initial condensation in the cylinder. With saturated steam this initial condensation amounts to from 15 to 50 per cent. of the weight of steam admitted to the cylinder. With superheated steam the degree may not be sufficient to insure dry steam at cutoff, yet the loss of heat and the slight condensation at the beginning of the stroke are insignificant compared to those of saturated steam. Moreover, the steam that is condensed by the conversion of latent heat energy into work during expansion, is reëvaporated during exhaust.

TABLE 5. SHOWING GAIN IN EFFICIENCY OF ENGINE

Number of Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Superheating surface, sq.ft.	576	576	576	576	576	675	675	675	775	775	775	775	775	775	775	775	775
Superheat, deg. F.	45.0	35.3	34.6	35.6	39.3	45.8	45.8	40.9	47.8	52.2	64.3	61.7	61.3	55.0	63.1	63.0	66 8
Amount of superheating in 1 lb. steam, B.t.u.	27.0	21.2	20.8	21.4	23.6	27.5	27.5	24.6	28.7	31.3	38.6	37.1	36.8	33.0	37.8	37.8	40 2
Horsepower increase due to superheat	2.1	2.7	2.8	3.9	4.0	3.7	4.4	4.7	2.9	4.3	5.5	5.7	6.1	5.5	6.6	6.8	7 5
Percentage horsepower increase due to superheat	2.2	2.1	2.1	2.0	2.0	2.5	2.4	2.5	2.6	3	3.4	3.3	3.3	2.9	3.3	3.4	3 7
Increase in specific volume due to superheat, per cent	7.8	5.9	6.9	5.9	7.2	7.8	8.2	7.6	7.6	9.0	11.1	10.1	10.9	9.5	11.1	10.8	12 5
Theoretical gain in engine efficiency due to superheat, per cent	4.3	3.4	3.3	3.4	3.7	4.3	4.4	4.7	4.7	4.8	6.0	5.8	5.8	5.1	5.8	6.0	6 3

It is well known that the theoretical economy of the steam engine depends upon the difference in temperature between the exhaust and the entering steam, or, in other words, the greater the drop in temperature in the engine, the greater the efficiency. A gain in efficiency can only be had, therefore, by increasing the temperature of the entering steam or decreasing that of the exhaust. To obtain an increase of 50 deg. F. in saturated-steam temperature by increasing the pressure would mean an increase from 150 to 272 lb., which is impracticable and shows that no great gain in economy can be produced in this direction. Table 5 shows this theoretical increase in efficiency of steam engines when using steam under the conditions of these tests.

The advantage and economy of superheat for use in turbines are just as pronounced. Aside from the economy there is an important advantage arising from the fact that superheated steam materially reduces the erosion of the blades by the action of water that would be carried by saturated steam. By superheating moderately, the water that exists in the low-pressure stages is reduced to a quantity that will not cause trouble. The value of this

superheat in turbines is illustrated by the fact that in one plant that carries 200 lb. pressure on the boilers and has a superheat of 150 deg. F. produced in a superheater installed in the flue, the steam is used as produced, with superheat, in the turbine with maximum economy. To use it in the reciprocating engines in the plant, however, it is necessary to inject a small stream of water into the pipe to reduce the temperature below the maximum degree possible in these engines.

Dryness of steam is an important requisite in some industries, and this is insured with a vertical fire-tube boiler of fair size, while the steam delivered from other boilers frequently contains as high as 3 per cent. moisture due to priming.

As regards the efficiency and economy of the boiler itself, it was not possible to investigate the variation of flue-gas temperature and efficiency for each of these tests, but on several previous ten-hour tests the boiler showed efficiencies averaging 70 per cent. for usual conditions, with an equivalent evaporation of 11 lb. of water from and at 212 deg. per lb. of combustible. The flue-gas temperatures averaged 70 deg. above that of the steam.

The ratio of total heating surface to grate surface is large in this boiler, being 72.8 to 1, and this accounts for the fair efficiency and moderately low temperature of the flue gases. The greater this ratio of total heating surface to grate surface, the lower the flue-gas temperature and, consequently, the higher the efficiency. The degree of superheat would have been greater with smaller ratio of water and superheating surface to grate surface, but the economy would have been less, even perhaps offsetting the gain due to superheat. But with fair proportions and proper designing, the economy of the vertical fire-tube boiler need not be less, and can be even greater, than that of a horizontal boiler and still procure the added advantages of delivering moderately superheated steam.

Thus, it is seen that all advantages arising from the comparatively small degree of superheat produced in vertical fire-tube boilers of proper design are cumulative and that the first few degrees are by far the most important and valuable, and especially so in small plants where it would not be advisable to install a superheater because of the extra investment and maintenance cost.

Panama-Pacific Exposition--VIII

SYNOPSIS—This installment treats of the exhibit of the National Tube Co., showing pipes of extreme size, different methods of joining pipes, apparatus for corrosion tests, method of drawing Shelby tubes, etc.

The National Tube Co. is a subsidiary of the United States Steel Corporation, and its exhibit forms a part of that corporation's display, which occupies over 45,000 sq.ft. of space in the Palace of Mines and Metallurgy and includes a motion-picture exhibition in which over six miles of film are used to show every important step in the manufacture of steel products, from the mining of the ore to the finishing of the completed material, as well as welfare work.

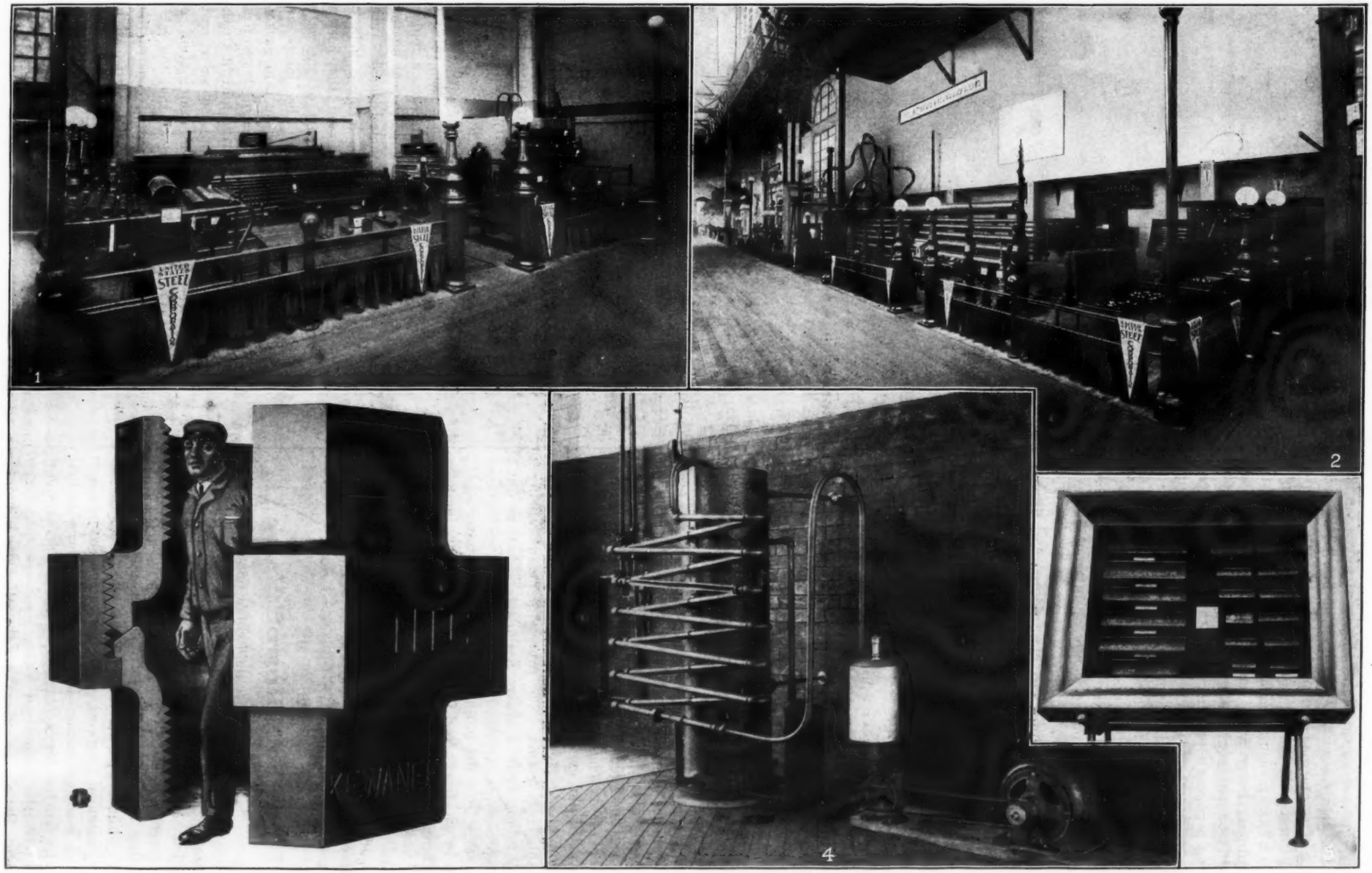
The National Tube Co.'s exhibit proper occupies an area of about 6,000 sq.ft. and is subdivided into three sections devoted to the three lines of products: National pipe and allied tubular products; Kewanee specialties, fittings, etc.; and Shelby seamless tubing and cylinders.

Entering the main section, a visitor walks through an arch, or kiosk, 15 ft. in height, made of miscellaneous bends of 4-in. National pipe, seen at the left in panel 2 on page 587. Immediately behind this is a rack on which are shown the various types of pipe used in the oil fields. The rack is capped by the largest length of lap-welded pipe ever made in America, a 20-in. O. D., 39 ft. 6 in. long, made at the McKeesport works of the National Tube Co. There is a collection of National pipe equipped with Converse, Matheson and Kimberley joints, and plain-ended National pipe, equipped with Dayton, Hammon and Dresser couplings. This is supported by a standard of 30-in. pipe, the largest made by the lap-weld process. There are three pyramids of Diamond B.X. casing telescoped to show the various sizes that can be telescoped within each other. There are a number of freak specimens of casing that have encountered unusual and severe service. One piece, originally about 18 ft. in length, was left in an oil well and received the entire force from the explosion of 170 qt. of nitroglycerin. The casing was crushed to a length of 5 ft. 6 in. and badly twisted and distorted, but not fractured.

Another piece of casing on the same rack has a stone embedded in it, which worked itself into the casing without causing the wall of the material to collapse while the well was being drilled. Another freak specimen shows the telescoping of two complete lengths and part of a third length of casing. These were on the lower part of a 1,640-ft. string of 8¼-in. casing that dropped 200 ft. to a limestone bed. It has been figured that the energy thus generated would amount to approximately 6,912,000 ft.-lb., so that it is not surprising that something had to happen to the casing. It is remarkable, however, that the three lengths telescoped so completely without injuring the material.

Two large mahogany frames, one of which is shown in panel 5 on page 587, with concealed electric lights, inclose samples of corroded pipe. These samples represent both wrought iron and steel and show actual comparisons of the two kinds of pipe taken from the same line, used for the same service and for the same length of time. Another exhibit is designed to show the strength and ductility of National pipe, which are demonstrated by flattening, bending, crushing, pulling, expanded-end, bursting and torsional tests.

There is also an apparatus consisting of a hot-water tank, a water heater with thermostat and air pump, and several coils of pipe made of alternate lengths of wrought iron, ordinary steel pipe and National pipe, shown in panel 4 on page 587. Air is injected into the hot water, which is forced up through these coils into the tank. The corrosion is quite rapid as the service is very severe, and the test shows the comparative results on the life of the different kinds of material. There is a collection of boiler-tube test pieces, another of the various



THE NATIONAL TUBE CO.'S EXHIBITS AT THE PANAMA-PACIFIC EXPOSITION

1—Shelby seamless steel products. 2—Kewanee specialties. 3—A man's-size Kewanee union. 4—Apparatus for testing pipe for corrosion. 5—Specimens of corroded pipes and tubes

types of joints used upon piping, two pyramids (one of threaded Boston casing and the other of line pipe) and a display of several pages of photographs showing properly and improperly ground pipe dies and the important points in a chaser, such as lead, clearance and chip space.

In pumping heavy oil a certain amount of water is added. The pipe in which it is conveyed is rifled and the rifling produces a twirling effect, throwing the water to the outside, where it acts as a lubricating film or carrier for the heavy oil. Samples of the rifled pipe are shown. There is also an exhibit of various types of protective coatings. A multiple display rack carries mounted pictures of various products in the manufacture of which National pipe is used either wholly or in combination. A projectoscope shows 75 different views of the manufacture, inspection, testing, use, etc., of pipe and allied products, a picture being projected every 30 seconds.

The right-hand portion of the main booth, shown at the right in panel 2 on page 587, is devoted to the display of Kewanee specialties, including the Kewanee union, N.T.C. regrinding valve, brass fittings, cocks and valves, malleable and cast-iron and wrought fittings. The dominating feature of this section of the exhibit is a colossal model, made to exact proportions, of a 2-in. octagon Kewanee union. An eighth section has been cut from one side of the model in order to show in cross-section the brass-to-iron thread connection, brass-to-iron ball-joint seat and three-piece construction. Near-by is a working model of a testing machine used to give each union a 125-lb. compressed-air test under water. A complete line of Kewanee specialties and fittings is displayed on a multiplex swinging-leaf exhibit rack.

Across the aisle from the Kewanee section is the exhibit of Shelby seamless tubing and cylinder, shown in panel 1 on page 587. The feature of this exhibit that attracts the most general attention is a set of furniture, consisting of six chairs, one settle and a table, made entirely of Shelby seamless tubing. The top of the table is made up of numerous short sections of tubing in every conceivable cross-section. The process of manufacturing seamless tubing from a square flat plate, known as the cupping process, is explained in an exhibit that shows the various steps from flat to finished cylinders or tubes, and a model in which soft lead is used for the working material. There is a special exhibit of large cylinders. The largest, tested to 3,000 lb., is used in connection with an oil engine. Two special cylinders are made to stand an air pressure of 5,000 lb. per sq.in. A projectoscope also illustrates the manufacture and uses of Shelby seamless tubing and allied products.

"Hovalco" Blowoff Valve

It is common practice to use the twin or double blowoff-valve arrangement on steam-boiler blowoff lines. These valves are usually of different types, such as a plug-cock and angle-type valve or a gate and an angle-type valve. This arrangement, aside from safety, gives double assurance against leakage, and the valve nearest the boiler can be closed while the second valve is repaired.

The Homestead plug-cock valve has long been used as one of such a combination, and in order to be able to supply the demand for both valves on the double blowoff arrangement, the Homestead Valve Manufacturing Co., Homestead, Penn., is now making the "Hovalco" angle-type blowoff valve to use in connection with its plug cock, as shown in Fig. 1.

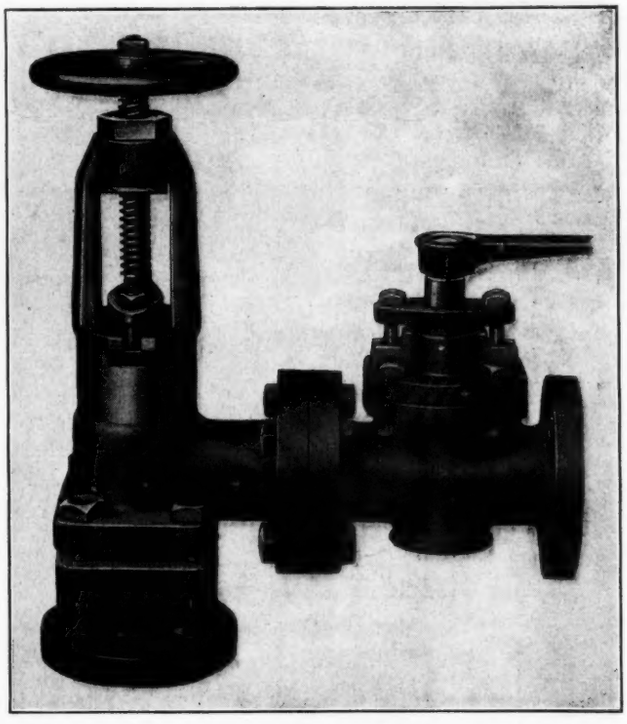


FIG. 1. DOUBLE BLOWOFF ARRANGEMENT OF PLUG COCK AND "HOVALCO" VALVE

The construction of the "Hovalco" valve is shown in Fig. 2. The valve body is made of semi-steel, the seat and disk are made of monel metal.

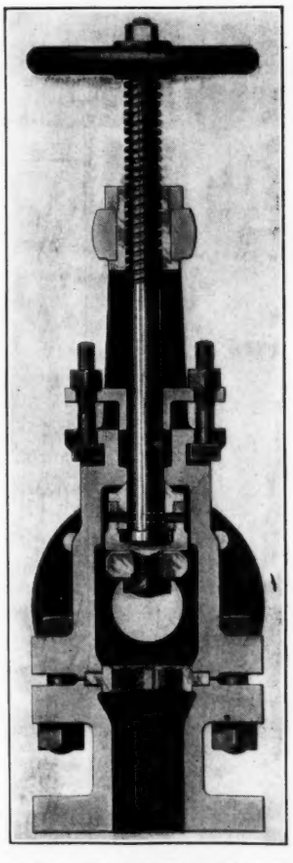


FIG. 2. SECTION THROUGH "HOVALCO" VALVE

The seat can be reground, reversed or renewed with ease, all that is necessary being to loosen the four bolts holding the valve body together, the seat being released at the same time. The disk can also be removed easily and is reversible. As shown in Fig. 2, the valve disk is above the port opening when the valve is open. The disk has a double-beveled face to seat against the double-beveled valve seat. The latter is held in place between the bottom and top part of the valve body, and the joints are made tight by thin gaskets on both sides of the projecting seat ring and fit in the recesses in the valve castings. An examination of Fig. 2 shows that the valve is of heavy construction and that the parts can be easily renewed. The valve is designed for 250 lb. pressure in 1½- to 3-in. sizes and with screwed and flanged body.

Editorials

Taking the Bull by the Horns

Central stations have been none too ready in the past to acknowledge the limitations of their service with respect to the purchaser's cost sheets, but a new point of view was evidenced at a recent convention of the New England section of the National Electric Light Association at Kineo, Me. Every engineer wishing to see the power-cost problem solved right for his employer must welcome so frank a discussion of the reasons why central stations do not get all the power business as occupied the meetings of an entire day on this occasion. That keen-minded commercial power men should have devoted so much time to listening to these minor chords of the central-station triumph song is thoroughly gratifying to those whose sympathies favor energy production by private plants except where it is clearly the right solution to purchase service, and our central-station brethren are to be congratulated for thus taking the bull by the horns.

There was a deal of speaking right out in meeting down there at Kineo. John J. Gillespie, of the United Shoe Machinery Co., as a representative of an outside industry, called attention to the ofttimes controlling influence of the heating problem, including steam needed for industrial purposes. He truly said that the central station that refuses to face this issue, analyzing the conditions thoroughly and standing ready to provide a combined steam and electric service in crucial cases—a service that will cost the manufacturer less per unit of output than formerly—simply runs the risk of failure to extend its business in a most important direction. Telling the manufacturer about the burdens of a wretched load-factor or the worries of readiness-to-serve elements in rate-making doesn't even capture his first line of trenches, let alone cutting the communications between the coal pile and the generator. Again, the fearsome complications of certain forms of power contracts, "the same having many ramifications and among others a sliding scale based on a maximum and minimum use and the Lord only knows what else," as per Mr. Gillespie, unquestionably stand in the way of the central-station advance. When the central station neglects one-third of the problems, as it frequently does, claiming that it has nothing to sell but power and light, it begs the question.

Not to be outdone in straightforwardness, H. B. Emerson, of the Arlington Mills, Lawrence, Mass., flatly declared that many individual industries build their own plants because they can obtain cheaper power from such installations and because they have absolute control over their power. The manager of a big mill knows that a shutdown means many dollars lost per hour, and he likes to have some individual to "get back at." That a line is put out of commission by lightning or a circuit-breaker opens for some reason foreign to his own plant means nothing to him. He is no electrical engineer, and anything not subject to his own installation is no excuse to him. With a station of his own his lines are not subject so much to weather conditions or to the widely diversified circumstances bearing upon the central station; and should any damage occur to his own plant, there is the central station to fall back upon.

New England is one of the hardest fields for central-station work in the country, since there are within its borders more small water-power privileges per square mile than elsewhere in the United States, and on account of the distances from the mines, coal is high. According to Mr. Emerson, a number of private plants are generating electricity in this section at from 0.75 cent to 1 cent per kilowatt-hour, including fixed charges.

Space will not permit extended comments upon the difficulties set forth by Messrs. K. P. Applegate, Hartford, Conn.; J. E. Gray, Providence, R. I.; J. E. Spike, Cambridge, Mass.; John West, of the Tenney syndicate, Boston; and H. W. Eells, Augusta, Me.—all progressive central-station power engineers who acknowledged that their class of service is by no means ex-officio the only solution of the power problems of modern industry. But it is worth noting that such points as the following are pertinent: Desire of the mill owner to retain his independence in power production, even at the cost of not saving a few hundred dollars a year in some instances; inability of central-station power solicitors to overthrow the factory owner's confidence in the figures of his own staff, when these were not in agreement with those of the central station; desire to utilize existing investment in power-plant equipment to the full; virtual equality of service standards between large or well-run small isolated plants and central stations; discrepancies between rates for similar power and lighting services in adjacent territories occupied by different companies, but dealing with a common customer through ownership or lease of premises in more than one community; long useful life of standard isolated-plant generating equipment; hasty general statements by the solicitor as to the savings to be effected by purchased power; errors in application of purchased power in other local establishments through inadequate investigation; lack of a monopoly of the advantages of the motor drive by the central station; inability in some cases to secure a profitable market for waste products; and finally, inability of central-station lines in some occasions indicated by Mr. Eells to meet speed-control demands—notably in connection with the demands of paper machinery, rolling mills, steam plunger-driven carriages in sawmills, hoisting engines, and other machines requiring uniform motion with the ability to change the speed by infinitesimal steps, reciprocating motion at variable but accurately controlled intervals, and quick acceleration. Sometimes, too, the central station takes on a large customer at the wrong time in its financial history; perhaps when the plant is heavily loaded, leading to poor service in some cases, with bad regulation as a concomitant. Fearless recognition of these difficulties contributes as much to correct engineering solutions of power problems as the much easier practice of stressing the economic benefits of centralization.

Does Live-Steam Heating Boost the Coal Bill?

An engineer is operating some generators. He uses exhaust steam for heating. Suppose he shuts down his generators and supplies live steam from the boiler to his heating system. He would then naturally expect to burn less coal. The actual decrease would depend on the coal equivalent of the electrical energy previously generated.

Suppose now that the engineer finds that his coal consumption is actually greater when he is using the live steam. Should he conclude that electric power is a byproduct, a welcome left-over, obtained with consumption of less fuel than is required when taking steam from the boilers for heating only?

The engineers who believe that the use of live steam increases the coal bill have evidently forgotten that under like weather, temperature and building conditions the heat used with live and exhaust steam is the same. Surely it is absurd to say that the less heat to be supplied the more coal must be burned. But this is argued by those who assert that with live steam the heating system takes more coal than does the combined load of generators and of the same system heated by exhaust steam.

There are some people who will persist in doubting results that seem to upset the laws of science. They will even hold that it is dangerous to draw broad conclusions from incomplete evidence. In this specific case these unbelievers consider that an analysis of the use of the live steam and an examination of any and all causes contributing to results from which unreasonable conclusions are derived will tend to show that the principle of the conservation of energy must still be considered in power-plant engineering.

The other side of the shield is viewed by C. C. Wilcox, who last June, before the National District Heating Association, gave test results indicating that the heat consumption for a heating system under similar weather conditions is practically the same for either live or exhaust steam operation and that the carrying of an electric load in addition to the heating load cannot be accomplished without an increase in fuel. The results are what would naturally be expected.

⁂

What the Modern Power-Plant Engineer Must Know

John B. McGowan, in a paper upon "The Future of the Operating Engineer," recently delivered to N. A. S. E. No. 8, of Brooklyn, N. Y., tells of an aspirant for a very desirable position, who had succeeded so far as to be invited to appear before a committee for examination as to his qualifications. Elated but anxious, he sat up all night refreshing his memory as to boiler design, superheat, areas and dimensions of everything he could think of, engine design, valve setting, indicator practice, power distribution, refrigeration, thermodynamics and applied mechanics. He tried to absorb so much in a short time that toward morning he fell asleep, exhausted.

When, however, he appeared before the committee, nervous but confident, the examination proceeded along a totally unexpected line:

"Mr. Blank, the appraised valuation of this plant is $53,000. What, in your estimation, should be the rate of interest on the investment?

"What proportion of the total fixed charges would you credit to depreciation?

"What would you consider the proper maintenance cost of boilers per horsepower per year?

"What class of repairs would you have done through outside sources?

"Are you in favor of a bonus system in the fire room?

"Do you favor the buying of coal in cargo lots or by contract through a regular dealer? How far do you follow the B.t.u. method?

"What is your estimate of the cost per kilowatt-hour in a plant of this type, the total output being 420,000 kw.-hr. per year?

"Explain your methods of labor charges and department credits.

"Give an idea of how you would conduct your stock and tool room.

"How would you arrive at the annual cost of refrigeration per cubic foot at twenty-eight degrees, compression system, no charge for circulating water, compartments practically tight, charges for floor space being twenty dollars per square foot per year?

"Are you in favor of separating the various branches in your department under responsible heads, aside and apart from the chief engineer?"

Now what does all this signify? It simply means that the committee conceded the fact that he was an engineer. His record proved that, and they could not go behind it. Then why waste time quizzing him regarding his middle name? On the other hand, they were not so sure of his business ability, nor quite certain of his conception of values. They wanted to know to what extent he had studied the business end of his vocation and how far he was capable of its administration. These things the modern power-plant engineer must know with an every-day working knowledge, in addition to the operative knowledge that comes from daily contact and practice with the apparatus that he operates, and a knowledge of the fundamentals of the processes that he conducts.

⁂

When the announcement was made some weeks ago that the service of the Brooklyn Edison Co. had displaced the large private power plant of the American Manufacturing Co., speculation was rife as to how the deal had been consummated. It now appears that the Brooklyn Edison Co. after thorough investigation, finding itself unable to better the figures of the private plant at the regular rates, made a proposition based on an off-peak load. Accordingly the American Manufacturing Co. changed its working hours, closing down at 4:30 instead of 5 p.m. so that it would be off the lines before the peak of the central station came on, and the proposition was accepted.

⁂

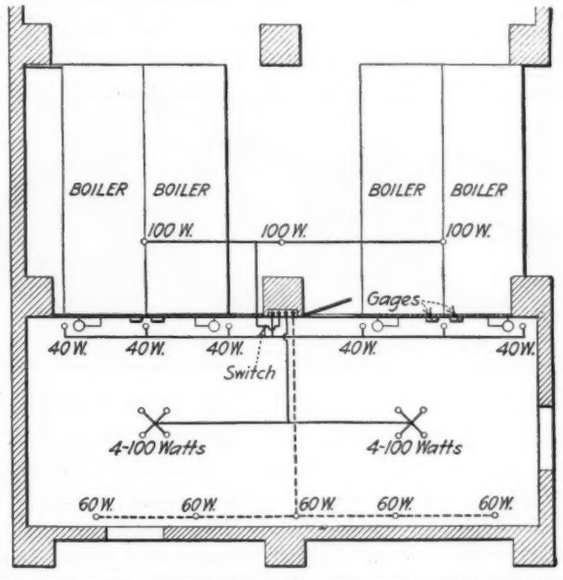
An "educator" declares the present college system to be "four years of loafing." If this be true, to what sublime indolence may the young electrical and mechanical engineer of the future look forward! In many instances most heroic efforts are yearly being made by young men to acquire a fitting technical training, that they may take their places in the industries as real engineers. "Four years of loafing?" This is raking the muck with a vengeance!

Correspondence

Lights in the Boiler Room

In many plants ample lighting is provided in the engine room but that in the boiler and pump rooms is open to a great deal of improvement. One of the best-lighted boiler rooms I have ever seen, where artificial lighting is depended on 24 hr. a day, is represented in the accompanying sketch.

There are four boilers set in two batteries. All the wires are run in conduit with flush switches. The water



PLAN OF BOILER ROOM, SHOWING LIGHTING CIRCUITS

columns are placed at the outer corners of the boilers and the steam gages of the two adjacent boilers are set near together.

The feeder circuit comes from a near-by panel box and is run through conduit to the 4-gang switch box mounted on the pillar in the center of the boiler room. One switch controls the lights on the four water columns and steam gages; the second switch controls the lights over the tops of the boilers, back of the partition; the third controls the lights over the firing floor in front of the boilers; and the fourth controls the lights in the basement, where the ashes are taken out.

Over each water column there is an outlet box from which a short piece of armored cable is dropped to a little above the top of the water glass. These drops are fitted with keyless sockets and also a tin reflector which throws the light against the water glass and protects the eyes when looking at the glass, and the water level can be easily seen at a considerable distance. The drops in front of the steam gages are arranged in a similar manner. Each carries a 40-watt tungsten lamp.

There is a sheet-metal partition between the boilers at the front end as indicated, the object being to keep the boiler room cool, as the heat radiated from above the boilers is taken care of by ventilating fans. The conduit over the boilers has three outlets—one located about midway over each battery and one over the passageway between the boilers. Each of these sockets carries a 100-watt tungsten lamp. In front of the boilers, over the firing floor, there are two pipe chandeliers, each having four sockets carrying 100-watt lamps. In the basement, which is 6½ ft. high, the conduit is placed on the side wall near the ceiling and has five outlets, in which 60-watt lamps are used.

The brick walls of the boiler room are painted white with a wainscoting of drab about 4 ft. high, which greatly assists the lighting. The lighting requirements in the offices and other rooms of the main building are very exacting and after the lamps have been used there for some time, and their candlepower has decreased somewhat, they are used in the engine and boiler rooms where they are good for many hours' service.

In this boiler room there is a total of 832 candlepower in front of the boilers, 240 candlepower over the boilers and 240 candlepower in the basement. The lights over the boilers and in the ashpit are switched on only when necessary.

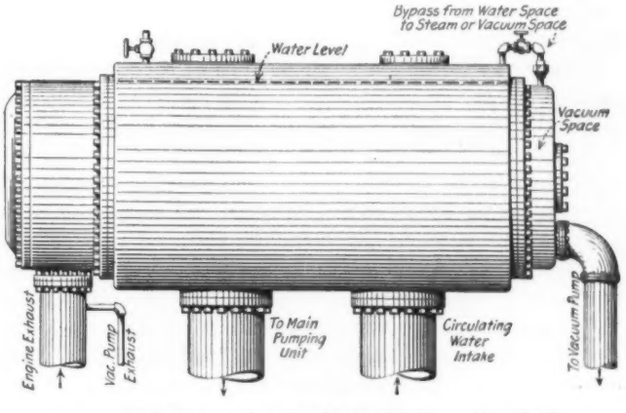
J. C. HAWKINS.

Hyattsville, Md.

Removing the Air from Surface Condensers

Two surface condensers were connected in the main pump suction line so that the incoming water flowed over the tubes to perform condensing duty.

While the suction head of these units was quite low, trouble was experienced in keeping the condensers full.



ADJUSTABLE BYPASS CONNECTION AT TOP

After a few minutes' running with insufficient water they would get hot and had to be shut down and cooled off. To remove the air and insure the complete filling of the condensers with cold water a bypass was connected between the vacuum space and the circulating water space at the highest point.

By putting on the vacuum pump before starting the engine, we were able to give the suction-water space a share of the vacuum intended for the engine exhaust,

and no more trouble was experienced. The discharge head is sixty feet, while that of the suction is about four. Some discussion as to the best place to put a condenser, whether in the supply or discharge lines of pumping units, would be interesting.

EDWARD T. BINNS.

Philadelphia, Penn.

Leakage of Superheated Steam

Referring to the article by C. E. Anderson, page 383, Sept. 14, I cannot quite agree that his steam test is conclusive. As I look at it, it is no test at all. We all know that saturated steam will carry more moisture with it in going through an opening than superheated steam will, and that accounts for the difference in time required to fill the flask; but I believe that a larger volume of superheated steam will pass through than of the saturated steam, although the superheated does not carry as much moisture as the saturated.

I would prefer to arrange a test so as to meter the steam that would pass through an opening in a given length of time, by connecting a gas meter to the outlet of the cylinder, then passing some absolutely dry air through the leakage and noting the time required for a given amount, then doing the same with air containing a large amount of moisture. Noting the difference in volume would give a more definite result.

F. M. BENJAMIN.

St. Cloud, Fla.

Paper-Mill Power Plants

This seems to be the season for declaring the shortcomings and bad practices in paper mills. Ours consist chiefly in boiler abuse brought about by the use of the boilers up to about 3 a.m. Sunday morning, when two are dropped off, cooled as rapidly as possible, and a cold-water hose used to wash them inside and out. The occasion for the external washing is that the hot gases pass over the top of the boiler after leaving the tubes on their way to the stack. This type of setting is locally termed a "double-return." The effect on the boiler and setting by the use of cold water in an attempt to remove the sediment from the inside and soot from the top of the boiler can be imagined. The boiler maker is frequently called on to roll tubes and the brick mason to repair the furnace and setting. By noon the cleaning is done and the boilers filled and closed up—quick work. Another exceedingly bad practice here is the use of water in the furnace during fire cleaning, to loosen and break up the clinkers to make them easy to remove. Grate bars, dead-plates and furnace lining suffer as a result.

The feed-water heater is "way yonder" in the mill, in a cellar, and a pump is used to deliver the hot water through a 5-in. line, buried in the ash dump, to a tank in the boiler house. This pipe line has to be renewed every two or three years on account of excessive corrosion in the ash dump; besides, many good B.t.u. are lost. Some wise fellow had persuaded the superintendent that it was necessary to place the heater low for the safety of the engines. The boiler-feed and fire pumps are in the boiler room in about the likeliest place to receive injury by grit and ashes.

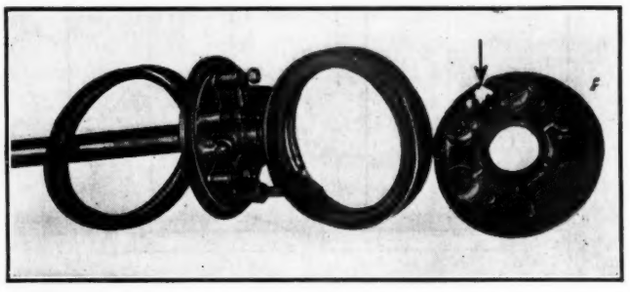
We are, however, making considerable progress with improvements in the furnaces, which were no doubt built for anthracite and are too restricted for good results with soft coal. Deepening the combustion chamber, an extra supply of air through checker work, and combustion arches built in together with differential draft gages and independent dampers have helped the CO_2 and reduced the black smoke considerably. The use of dampers instead of the ashpit doors to regulate the rate of combustion and deepening the ashpits and keeping them clear are showing a wholesome effect on the life of the grates, as was to be expected. We hope to continue the good work.

T. J. FRANCIS.

Mount Hope Ga.

Another Piston Accident

On taking charge of a plant I noticed a peculiar rattle in the cylinder of an 18x36 engine, but was told that numerous efforts had been made to locate and remedy the



LOOSE CAPSCREW WORE THROUGH FOLLOWER PLATE

trouble without success. The second day, however, a couple of sharp knocks were heard, after which the engine ran quietly; but that night the cylinder head was removed and a small hole was discovered in the follower plate.

Further investigation showed that one of the centering screws had worked loose and vibrated between the plates until a hole was worn through and the capscrew had been worn small enough to pass out into the cylinder, where it was found in the drain-pipe opening. A new piston was put in, and the mystery of the rattle in the cylinder was cleared up after about nine years' time. The illustration shows the type of piston, and the location of the hole is indicated by the arrow.

WALDO WEAVER.

Beacon Falls, Conn.

Valve Was Put on Wrong

The water in one of the boilers went down, and all efforts to get water into it having failed, the fires were dumped. Investigation revealed the "mystery." Angle valves had been used in the feed lines at the top of the boilers between the check valves and the boilers and had been connected with their stems extending vertically. The disk had jarred off and fallen upon the valve seat, closing the opening completely.

Such valves should be so placed that the disk will not be held to its seat by the pump pressure and will not be able to close the opening even if it does come off the stem. "An ounce of prevention is worth a pound of cure" or an undertaker's bill.

EDW. T. BINNS.

Philadelphia, Penn.

Economizers in Modern High-Pressure Power Plants

Referring to the article by C. F. Hirshfeld in the Sept. 13 issue, describing the Connors Creek Station of the Detroit Edison Co., I would appreciate the opportunity to correct the impression which Mr. Hirshfeld's statements regarding economizers create.

Fuel economizers, when constructed with metal joints, can be built to carry any pressure demanded at the present time and with a factor of safety at least equal to that required on the steam boiler. I cannot believe that Mr. Hirshfeld investigated the economizer situation carefully and arrived at the conclusion given in his article. Economizers are built as a commercial product with factors of safety above the operating pressure on the machine of never less than 4 and ordinarily 5 to 6. They have recently been furnished one of the largest power users in the country in which 3,000 lb. hydrostatic pressure has actually been put on a complete section without any apparent weakening.

No economizer leaves our plant without having been tested to at least twice the pressure under which it will operate, and every economizer shipped has a known factor of safety of at least 5.

WILLIAM N. ROSE,
Hyde Park, Mass. B. F. Sturtevant Co.

Over $4,000 Saved in Small Refrigeration Plant

If the statement were made in a matter-of-fact way that someone found that a portion of the cooling surface was frozen in a brine cooler, it would seem commonplace, because brine coolers often become frozen when the brine becomes too weak or when the suction pressure is run abnormally low or when the brine circulating pump stops for some time unobserved. But the statement means more when it bares the fact that a 50-ton brine cooler lost fully half of its capacity for a whole season when ice was selling at the platform for four dollars a ton; and this in spite of the fact that the trouble was sought for months, a consulting engineer having been called in and the builders of the machine having had representatives on the job at various times.

The cooler was in an absorption system, and the trouble was variously attributed to other parts of the system without carefully testing these parts.

One indication above all others should have quickly located the trouble in the brine cooler; that is, the enormous difference in temperature between that of the brine and that of the liquid ammonia in the cooler. A casual calculation would have shown the low rate of heat transmission that was being obtained in the coil surface in the cooler. A few figures will serve to illustrate this. A 50-ton cooler of this type—that is, the Hendrick type with vertical shell and spiral coils—is provided with about 500 sq.ft. of coil surface. When working to its rated capacity, this surface must transmit 600,000 B.t.u. per hr., or 600,000 ÷ 500 = 1,200 B.t.u. per hr. per sq.ft. of surface; and with a mean difference in temperature of 12 deg. F. between that of the brine and that of the liquid ammonia in the cooler, the rate of heat transmission would be 1,200 ÷ 12 = 100 B.t.u. per sq.ft. per hr. per degree of mean difference in temperature, which is about right for this type of cooler. It is always well to check up the rate of heat transmission in coolers and condensers occasionally and see that they are working as they should.

But the foregoing was not the only trouble in this plant. There was a large amount of ammonia waste, which had been attributed to the inherent greed of the absorption system for ammonia when the real cause of the waste was leakage about the plant. Several compressor cylinders were also in bad shape. These conditions being corrected, the operating cost for the next season for almost the identical output showed a saving of approximately $2,000 in coal and $2,000 in ammonia, to say nothing of the saving in labor and other expenses.

New York City. R. L. SHIPMAN.

Turbine Examination Questions

The following questions were asked and the answers given at a recent examination for a first- and second-class Massachusetts engineer's license:

1. Give a comparison of the impulse and the reaction turbine.

Impulse: Few stages, expansion in nozzles, large drop of pressure in each stage, initial steam velocities are in general high, 1,000 to 4,000 ft. per sec., blade speed 400 to 1,200 ft. per sec.; best efficiency when the blade velocity is nearly half the steam velocity. Reaction: Many stages, no nozzles, small drop of pressure in a stage, all steam velocities are low, 300 to 600 ft. per sec., blade velocity 200 to 400 ft. per sec.; best efficiency when blade velocities barely equal the highest velocities of the steam.

2. State four ways of governing.

Throttling steam supply; varying time of admission, called blast governing; cutting out nozzles, and admitting steam from the boiler at various points along the steam line, called bypass governing.

3. How is it that there is no side thrust on a Curtis turbine?

Because the steam enters and leaves the blades at the same angle.

4. What advantage has the relay system of governing over the direct?

Much force is needed to move the valves, and unless they are carefully balanced with the direct system the governor is not sensitive. With the relay system the governor only gives the signal, as it were, and the valves are moved by auxiliaries worked by an independent pressure.

5. What is the difference in the action of steam in the impulse and the reaction types?

Impulse: steam does not expand in the blades. Reaction: steam expands all through the turbine.

6. What is a stage in a Parsons turbine?

A set of moving and a set of stationary blades.

7. What is a stage in a Curtis turbine?

It differs, as it may have more than two sets of wheels in a stage.

8. What is absolute and relative velocity?

An absolute velocity of a body is its velocity in respect to immovable points of the earth. Relative velocity of a body is its velocity with respect to bodies that are also moving.

9. What is the rotor on a Parsons turbine?

The shaft with the bucket wheels on.

10. In what type of turbine does impulse and reaction take place?

In the Parsons.

11. How much is the clearance between the blades on a Curtis turbine? On a Parsons turbine?

On Curtis, $\frac{1}{32}$ to $\frac{1}{16}$ in.; on Parsons, $\frac{1}{8}$ to $\frac{1}{2}$ in.

12. How is the speed of bucket wheels reduced?

By using more than one set of bucket wheels, each set doing an equal amount of work.

13. How many types of turbines are there?

Two—impulse and reaction.

14. How many stages has a Terry turbine?

The noncondensing has one; the condensing has two.

15. What does the step bearing on a vertical Curtis turbine run on?

Oil or water.

16. How many ways of governing has a Curtis turbine?

Two—electrical and hydraulic.

17. Why is it that the pressure on top of the bucket wheels on a vertical Curtis does not push the wheel cup-shaped?

Any pressure that is on top of the wheel is also underneath so that the pressure is balanced.

Worcester, Mass. WEBSTER LEONARD.

Niagara Should Be Utilized

I believe that one of the greatest crimes of the day is burning coal where waterpower can be harnessed and made to do the same work; therefore, if damming the Niagara River above Lewiston is practicable, as described in the issue of Sept. 21, page 416, and can be done on a paying basis, certainly this scheme should be pushed through without delay.

All possible use should be made of water throughout the country in the interest of the whole people in conserving the coal supply for future generations.

Bondsville, Mass. E. G. CHILDS.

Quick and Cheap Repair Job

A few weeks ago we had to cut out and replace 150 tubes in a Heine boiler. The repair time and cost seem rather good and I am sending you the figures, as they may be of interest to others.

The work was done by four men, except as noted later—three at $1.25 and one at $1.75 per day of 10 hr., making a total of 55c. per hr. for all. Work was started at 7 Sunday morning. Blowing out the water, removing the tile and handhole plates were done by noon. Cutting out tubes began at 1 p.m. and was finished at 8 a.m. Tuesday, having taken 16 hr. After the removal of the débris, placing the new tubes began at 1 p.m. Tuesday; all were in place by 6 p.m. The actual work of rolling the tubes was begun Wednesday at 7 a.m., and one end of 138 were rolled in 10 hr. by one man; the remainder, after supper. The other men were occupied in cleaning handhole plates and crowfeet. Thursday one man rolled the other ends of the tubes while the other men were replacing handhole plates. Friday the work of closing up the rear end of the boiler was finished, but cold water showed one leak, which was rerolled, then tested to 225 lb. with no leaks showing. The baffle tile was replaced, the boiler fired up and cut in at 5:30 p.m. Friday.

Labor at 55c. per hr. for 75 hr., extra help 12 hr. at 55c. per hr., and bonus given for good time made, altogether, a trifle less than $50 for the entire job, or approximately 33⅓c. per tube overall expense.

The work was carried on under the direction of Chief Engineer W. T. Perry, who is responsible for the results obtained. R. L. ELLIS.

Selma, Ala.

Checking Pressure Gage in Refrigeration Plant

Engineers in small plants do not usually have a gage-test set, so the following suggestion is offered to assist such men to determine the accuracy of the pressure gage.

Since anhydrous ammonia, when undisturbed, assumes a pressure due to its temperature, the engineer can, with the aid of ammonia tables, compare the pressure shown by the gage with that due to the temperature of the cooling water flowing over the ammonia condensers. When the compressor has been stopped long enough to allow the ammonia condenser to assume the temperature of the cooling water, the gage should register a pressure due to that temperature, as shown by the ammonia tables, a copy of which every refrigerating engineer should have.

If the temperature of the cooling water is 75 deg. F., the gage should register 126 lb. Should the pipe connecting the gage to the discharge pipe have a rise of several feet, this vertical part is liable to fill with liquid ammonia, in which event the gage would register a higher pressure than that due to the water temperature, depending upon the height of the vertical part of the connecting pipe. In most cases, however, this liquid head is so small as to be negligible.

Atlanta, Ga. GAY A. ROBERTSON.

Repair to Heater Tubes

In the June 1 *Power*, G. E. Miles describes a method of making a temporary repair to a leaky heater tube.

A 1-in. corrugated copper tube in our feed-water heater was leaking badly, and a temporary repair was effected by inserting a piece of ⅜-in. iron pipe about 2 in. longer than the tube, with a long thread on each end. On each end was placed, first a washer or gasket of sheet packing, then a close-fitting iron washer, then a double thickness of sheet packing, followed by another iron washer and a nut, which was screwed up tightly to stop the leakage.

After being in use for some time a second tube started to leak and was repaired in the same manner; but when, after another short period of service, a third tube failed it was decided to renew the entire set of tubes, and the heater was cut out of service.

As no bypass was provided on either the exhaust or feed lines, it was necessary to install temporary piping around the heater for the feed water, while a temporary outlet for the exhaust was run to the rear of the building from a convenient tee. A connection was also made so that makeup water could be obtained from the hot-water service tank while the new tubes were being installed. When the two ⅜-in. pipes were removed, they showed no signs of having leaked.

East Las Vegas, N. Mex. HARRY ROEBUCK.

Inquiries of General Interest

Obtaining Fresh Water from Salt Water—Is there any process by which salt water can be made fresh by filtration?

C. A. L.

There is not, for once common salt (sodium chloride) is in solution, there is no substance that will render the sodium insoluble or in such condition that it can be filtered out. Fresh water is to be derived from salt water only by evaporation and recondensation.

Heat Developed by Drop Hammer—What quantity of heat is produced by a 500-lb. drop hammer falling from rest through a height of 3 ft.? H. B. L.

The work performed would be $500 \times 3 = 1{,}500$ ft.-lb., and as each foot-pound would develop $\frac{1}{778}$ of a B.t.u., the heat developed would amount to $\frac{1{,}500}{778} = 1.92$ B.t.u.

Detecting Crack in Engine Shaft—How can fine cracks in an engine shaft be detected? M. C.

Cracks or flaws in a smooth metallic surface are rendered visible by thoroughly moistening the surface with kerosene and then rubbing and drying it with a clean cloth and subsequently rubbing over the surface with chalk. The location of flaws will then be revealed by traces of the kerosene coming out again from the cracks into the chalk surfacing.

Efficiency and Factor of Safety of Boiler Joint—What is meant by efficiency and factor of safety of a boiler joint?

B. H. L.

The efficiency of a boiler joint is the quotient obtained by dividing the strength of a repeating section of length of the joint by the strength of a strip of equal breadth of the solid plate. The factor of safety of a boiler joint is the quotient obtained by dividing the strength of the joint at its weakest point by the load to be borne.

Engine Foundation Should Be Monolithic—Is there any need for the concrete foundation bed of a horizontal engine to be extended under the flywheel, if the main foundations and outboard-bearing pier are on good bottoms? H. L. F.

Where an engine foundation rests on soil, gravel or loose rock, trouble is likely to arise in preserving the engine-shaft alignment unless the bed and outboard bearing of the engine are supported on a monolithic foundation. For that purpose concrete foundation beds are usually made L-shaped, having the main foundation bed extended under the flywheel pit and the necessary distance beyond it for receiving the pier for the outboard bearing.

Size of Wire for Direct-Current Circuit—A group of one hundred 16-cp. 110-volt incandescent lamps is to be supplied by a two-wire direct-current system, at a distance of 400 ft. from the center of distribution. The allowable drop in this circuit is to be 2 volts. What size of wire should be used?

J. R. B.

The formula to be employed in figuring the size of wire for a two-wire direct-current circuit is

$$\text{Circ. mils} = \frac{22 \times D \times I}{e}$$

where D is the length of circuit (one way), I is the current in amperes, and e the allowable voltage drop in the two wires.

The ordinary 16-cp. 110-volt carbon-filament lamp requires about ½ amp., which in the present case would make the total current 50 amp. The distance D is 400 ft., and e is 2 volts. Substituting,

$$\text{Circ. mils} = \frac{22 \times 400 \times 50}{2} = 220{,}000$$

Referring to the wire tables, the nearest commercial size is a 0000 conductor, which has a cross-section of 211,600 circ. mils. This size of wire will safely carry more than 50 amp. without undue heating.

Correction of Gage Reading—If a correct steam gage is connected by ¼-in. pipe to the dome of a boiler, so that the bottom of the gage is 27.7 in. below the connection with the dome, how much more pressure would be indicated than the actual pressure of steam carried on the boiler? R. C. S.

In laying off the scales of steam gages, as by comparison with pressure exerted by a column of mercury or water, it is customary to reckon the height of column from the bottom of the gage dial, assuming that the bottom of the gage tube is at the same level and that for all indications the gage tube is filled with water. With the bottom of the gage dial 27.7 in. below the point of connection to a steam dome, the connecting pipe, from condensation of the steam, would become filled with water and the indications of the gage would be higher than the actual steam pressure in the boiler by the pressure per sq.in. exerted by a column of water of the same height and temperature, regardless of the size of the connecting pipe. The pressure per sq.in. exerted by a column of water 27.7 in. high will be the same as the weight of 27.7 cu.in. of water of the same temperature. Assuming the average temperature to be 100 deg. F. and finding, per the table of "Density and Volume of Water," page 542, Oct. 19 issue, that for 100 deg. F. the weight of a cubic inch is 0.0358767 lb., then the gage always would indicate $0.0358767 \times 27.7 = 0.99378$ lb. per sq.in. more than the true gage pressure of steam in the boiler.

Setting a D Valve at Given Point of Cutoff—How is a common D slide valve that cuts off at ⅞ stroke reset so as to obtain cutoff at ¾ stroke?

D. H.

Make a mark on the crosshead and corresponding marks on the guide with the crosshead at each end of its stroke, and from these locate marks on the slide toward the middle of the stroke at distances equal to ¼ of the stroke. Then turn the wheel forward until the mark on the crosshead passes the first quarter mark and comes opposite to the second quarter mark. The piston will then stand at ¾ stroke. Next uncover the steam chest, loosen the eccentric and turn it on the shaft in the direction of the rotation of the shaft until the valve has closed that steam port found to be nearly closed. Then fasten the eccentric on the shaft and turn the shaft forward until the mark previously made on the crosshead comes opposite to the other point of ¾ stroke marked on the guide, and note whether the other steam port is just closed. If it is not, lengthen or shorten the valve stem so as to correct one-half of the error and repeat all the operations until the valve just closes the steam port at ¾ stroke from each end of the cylinder. Thus advancing the eccentric to obtain earlier cutoff will hasten the lead and also the release and closure of the exhaust.

Noise in Sectional Flywheel—A 20-ft. dia. flywheel weighing 70 tons is built up in eight segments, each with one arm, held between two flanges of the hub by three 3-in. bolts, and the joints in the rim each held by two dogs, or links. Before the last pair of links was shrunk in the rim, the joint stood open about ⅛ in., but by the shrinkage of the links the joint was drawn together. When first started up there were two light snapping noises at each revolution, and since retightening all of the hub bolts there are five to six snaps to each revolution, all apparently in the hub of the wheel. What is the probable cause and the remedy? A. P.

The trouble undoubtedly arises from insertion of links that were not short enough to secure in them stresses from shrinkage in excess of the hoop stress of the rim due to centrifugal force, thus leaving dependence on the hub fastenings of the arms for resisting the centrifugal effects. Under such circumstances it would be difficult to decide whether each noise heard during a revolution was due to the grinding of one or more hub bolts. The remedy would be to slacken the hub bolts of one arm and remove two bolts from each of the other arms, retaining the central bolt of each slackened. Then with each rim joint drawn up tight, replace the rim links, one at a time, with links so short, when at red heat, that they can only just be inserted with good bearings at the shoulders. If the links have been designed of proper dimensions for resisting the hoop stresses when thus inserted, the initial stresses from shrinkage should materially relieve the hub fastening of the arms and with all bolts inserted the wheel should run without noise.

[Correspondents sending us inquiries should sign their communications with full names and post-office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

De Lancey Tubular-Valve Steam Trap

The De Lancey steam trap, Fig. 1, consists of three principal parts—the body, the valve and the float. The valve consists of a plug *A*, Fig. 2, with a hole of suitable size through the center. Midway of the plug at a

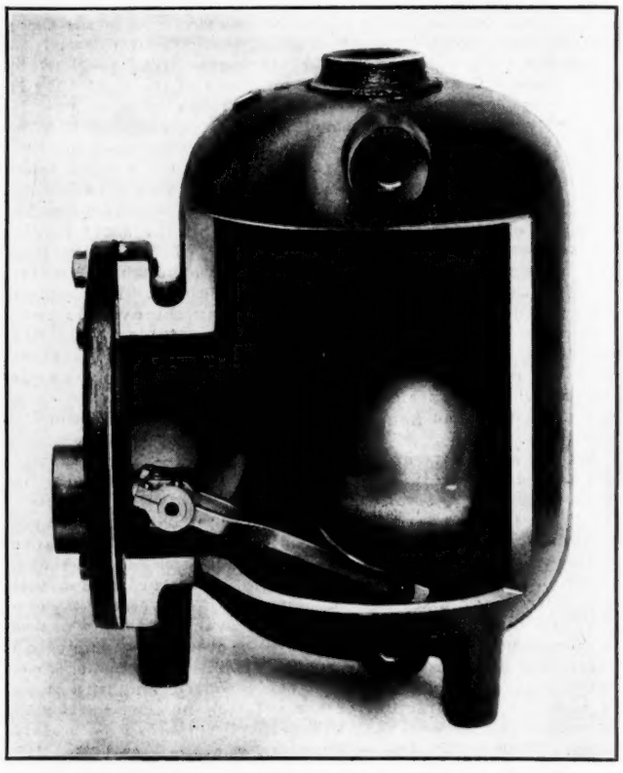


FIG. 1. SHOWING WORKING PARTS OF THE TRAP

right angle is a port which connects with the one through the plug.

The plug fits in a head *B* that is screwed into the outlet of the trap. The outside ends of the plug valve are clamped to the Y-float arm *C*, shown in Fig. 2, the float being loosely attached to the outer end and free

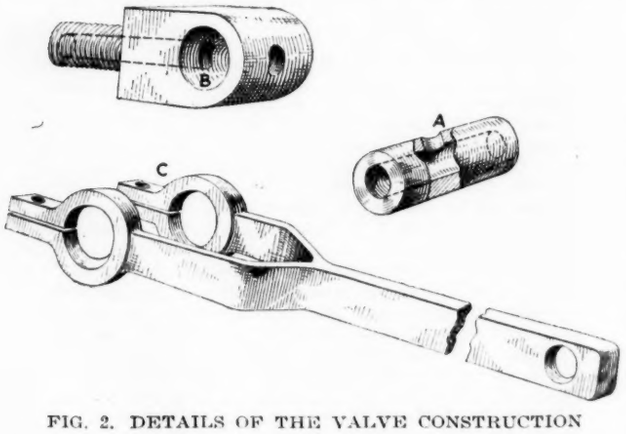


FIG. 2. DETAILS OF THE VALVE CONSTRUCTION

to assume a vertical position as the lever rises and falls. Fig. 2 shows the valve in detail.

The action of the trap is as follows: When the float is in the position shown in Fig. 1, the port in the plug is not in communication with the outlet, and consequently no water can escape. When the water coming to the trap raises the float sufficiently, the plug valve is turned until the port is in communication with the outlet. The water of condensation then flows through the center of the valve from both ends and discharges through the port *A* to the discharge outlet.

As the water is discharged the float falls, and the movement turns the plug valve so that the port *A* is not open to the discharge outlet. The balanced valve and the lever are made of bronze; the seamless copper float is made to withstand 300 lb. pressure.

The trap is designed to maintain the water level in the trap within close limits, and is made in sizes with capacities from 1,500 to 4,100 lb. of water per hour. It is manufactured by the De Lancey-Wills Steam Specialty Co., 96 Warren Street, New York City.

Canadian Hydraulic Power*

By Charles H. Mitchell†

The Dominion of Canada, lying entirely northward of the United States and stretching from the Atlantic to the Pacific Ocean, has climates and topographical features that include, possibly, all favorable and unfavorable characteristics, in so far as development of hydraulic power is concerned. The water powers of the Dominion are almost limitless, and while a great majority are remote from consuming centers, it is inconceivable, notwithstanding any radical changes in the art of power transmission, that the water powers will ever be completely commercially developed. The cities of Canada are fortunate in being within the zone of economic electrical-power supply from hydraulic sources.

The condition is general in Canada, that hydro-electric developments have approached or exceeded the unregulated capacities of their respective rivers, and while there are few extensive storage systems, the activity of industrial expansion demands that the power developments must anticipate the near future, must provide for the securing of maximum available outputs and that every advantage be taken for complete conservation and storage. Practically all Canadian rivers are naturally provided with storage possibilities.

GOVERNMENT CONTROL OF WATER POWERS

Effective storage requires relatively large areas of land for flooding purposes, and such lands, by growth of population and by the establishment of permanent improvements, increase in value at a rapid rate. The majority of the Canadian storage schemes now under way involve remote forested Crown lands adaptable for storage purposes. The interests involved in extensive developments makes the accomplishment of storage, in most cases, quite beyond the capabilities of the power-developing companies and requires concerted action in the obtaining of the necessary rights. In Canada, the Government acts as the intermediary, and this has been a very substantial factor in the success of the power situation throughout the country.

The Government of the Dominion of Canada has full control of all navigable and floatable streams and, in addition, through the Water Power Branch of the Department of the Interior, controls all water-power developments and possibilities in the Provinces of Manitoba, Saskatchewan, Alberta, the Northwest and Yukon Territories. Legitimate enterprise for the development of power resources is encouraged.

In the Province of Ontario, the Department of Lands, Forests and Mines, in conjunction with the Hydro-Electric Commission of Ontario, controls the water powers on other than navigable streams. The Hydro-Electric Commission is virtually a government commission acting in trust for municipalities that have combined for the securing of cheap power; its influence tends to the development and distribution of power under public ownership.

In the Province of Quebec, the Department of Lands and Forests controls the power in provincial waters, and through the Quebec Streams Commission has now under way an immense storage project on the St. Maurice River. Water powers of New Brunswick are administered by the Provincial Government, but in Nova Scotia a great portion of the land, with the included water powers, has passed from the control of the Government; the remaining sites, however, continue under full provincial control.

*From a paper presented at the International Engineering Congress.

†Consulting engineer to Dominion Water Power Branch, Department of the Interior, Canada.

In Nova Scotia, about 16 miles from Halifax, is a small yet interesting development on the Northeast and Indian rivers, which flow into St. Margaret Bay on the Atlantic Coast. The water available in each of these watersheds is conserved by storage dams. The water from the Northeast River is carried over the intervening height of land to a power house on the Indian River. The water under each of the two heads serves a generating unit, the discharge being into Indian Lake, at the foot of which another power house is situated, with tailrace at tidewater level. By conservation, the low summer flow is doubled.

On the Saguenay River, in Quebec, the outlet of Lake St. John (with an area of 350 sq.mi.), an enormous development is now under way, contemplating an output of 1,200,000 hp. with an initial installation of 300,000 hp. This immense capacity is justified by the low cost of power in large generating units of 50,000 hp. each, and will be used to manufacture nitrogen products for export.

The Quebec Streams Commission is constructing a storage system on the St. Maurice River, which supplies the Shawinigan and Laurentide (Grand Mere) plants. This system raises the minimum flow of 6,000 cu.ft. per sec. to 15,000 cu.ft. per sec., the effective drainage area being 16,200 sq.mi., and the reservoir dam at La Loutre impounding 160,000,000,000 cu.ft. This work will increase the power available at the now developed sites by 122,000 hp. at Shawinigan Falls and 63,000 at Grand Mere, and will improve six undeveloped sites on the St. Maurice aggregating 182,000 hp. capacity; rentals will be charged the individual users to defray the costs assumed by the commission.

Surveys have just been completed in connection with the storage possibilities on the Winnipeg River, on which two important power plants have been developed. The Winnipeg Electric Ry. has a 26,500-hp. plant on the Pinawa Channel, making use of the Du Bonnet Falls. The City of Winnipeg hydro-electric plant at Point du Bois, about 77 mi. northeast of Winnipeg, has an installation of eight units aggregating 51,500 hp. output, the ultimate plant to have an output of 76,000 hp. The Point du Bois site has a pondage of about 7 sq.mi. above the dam. The surveys show that the minimum flow on this river may be increased from 12,000 sec.-ft. to 20,000 by storage to be obtained in the headwaters in the Lake of Woods and the Rainy River and English River watersheds, where a combined area of 47,000 sq.mi. is drained.

RESERVOIR BUILT FOR CALGARY MARKET

The Bow River, in Alberta, rises in the Rocky Mountains and is subjected to severe climatic conditions affecting the river flow, which is from mountain streams, glaciers and snow fields. The facilities for power development on the Bow River at several locations adjacent to the power market of Calgary and the immediate requirement for regulated flow in the case of the Calgary Power Co. at Horse Shoe Falls, where the minimum flow of 550 cu.ft. per sec. was not sufficient for the market demands, resulted in the construction by the Dominion Government of a reservoir at Lake Minnewanka on the Cascade River, a tributary of the Bow. The Government proposes the installation of a hydro-electric generating plant that will use the stored water from the reservoir while in transit to the Bow River and thus secure an ample power service for the Town of Banff and the immediate surrounding portions of the Rocky Mountains Park. The park covers 1,800 sq.mi. and to a great extent includes all the areas required for the Bow River storage system, aggregating over 10,500,000,000 cu.ft.

Investigation is now under way by the Water Power Branch for the creation of storage for the Athabaska River, which has its source in Northern Alberta, some miles north of Calgary. This river flows toward the Arctic Ocean; and while having its headwaters extending far above Lesser Slave Lake into the Rocky Mountains, the winter conditions are such that the minimum winter flow is approximately 2,000 sec.-ft. at Athabaska Landing, as compared with the minimum summer flow of over 20,000 cu.ft. The power possibilities on this river are enormous, if the flow can be economically regulated; and the adjacent markets of Edmonton and the Peace River country—the latter Canada's last Great West—comprise an exceedingly attractive goal.

At the Stave Lake plant of the Western Canada Power Co., situated 36 mi. east of Vancouver, B. C., there is a storage, immediately above the power site on Stave Lake, capable of impounding the complete run-off from the glaciers and snow fields above; this storage reservoir has a total capacity of 14,000,000,000 cu.ft., which will serve the ultimate two power sites at this point. The output of the upper plant is at present designed to be 52,000 hp., with 40,500 hp. already installed.

The Coquitlam-Buntzen plants of the British Columbia Electric Ry. Co., situated on tidewater at Burrard Inlet, utilize two adjacent watersheds for storage. The Lake Coquitlam storage, in which the water of the Coquitlam watershed is collected, has a capacity of 7,623,000,000 cu.ft. The rainfall is excessive, averaging 156 in. per annum over the last 10 years.

In fact, Canada has limitless water powers. Practically all of those within economic range of markets or so situated as to be favorable for creation of industry have been developed. At present over 1,700,000 hp. is developed as hydraulic power, the greater portion of which is converted into electrical energy. In the near future several of the schemes of enormous size contemplated will doubtless be realized, with power units of capacity far in excess of any now developed.

Economic and Social Effects of Hydro-Electric Power*

By Frank G. Baum†

To determine the result of any particular industry on any period of progress is difficult, because usually many influences contributed to the total results. But we can in a way see the effect of hydro-electric power as a progressive influence. The aid that man is receiving from hydro-electric power is the end of a long period of development and preparation. The final and ultimate stage of this development is the use of water power, which is perennial and not subject to exhaustion. The electric transmission of energy over wide areas is as permanent as is the present system of distribution of water under pressure to municipalities. This hydro-electric development had its beginning about 1891 and assumed real headway about 1895, so that the industry may be said to be about 20 years old.

California, Washington and Oregon have possible water power of over 10,000,000 hp., which at 50 per cent. load factor can do the equivalent work of more than 150,000,000 men. Niagara has a possible 6,000,000 hp., or at 50 per cent. load factor the equivalent of more than 90,000,000 workers. Future generations will not toil while this power is kept idle mainly for a few tourists. At least the water should be put to work six days in the week, and the sight of the increasing and decreasing quantity as it changed on Sunday would give a very wonderful effect. California is variously estimated to have water-power resources of between 3,500,000 to 6,000,000 hp., and now has developed about 600,000. The amount developed is equivalent to 9,000,000 workers, or two workers for each inhabitant, assuming 50 per cent. load factor. But, as this was derived from 600,000 hp. in California and there is a possible use of over 100,000,000 hp. in the United States, we see that electrical power is truly in its infancy.

In 1912 the United States consumed 175.8 kw.-hr. per capita, which may be increased to 200 kw.-hr. per capita on account of isolated plants. The kilowatt-hours output for California was practically 10 per cent. of the total for the United States; and as the population is less than 3 per cent. of the total, it is seen at once that the kilowatt-hours consumed per capita in California is over 600. And in California saturation has not been reached.

The kilowatt-hours output for the United States has increased about four times from 1902 to 1912, but has increased in California nearly twelve times during the same period. California has been the leader in electric transmission and its hydro-electric horsepower has increased from 643 in 1892 to 584,511 in 1914—surely a remarkable result.

Hydro-electric transmission and distributing systems will ultimately form an electrical, metallic screen over the entire country. This will be a screen of equal and constant potential, under which service opportunities and rates tend to become equal. By building the transmission systems across and through valleys of California, there was formed a system which makes for the uniform and stable development of the state as a whole; the same will occur in other sections of the United States. Not only this, but the hydro-electric companies and those using waste coal use a waste to reduce a want, and in using this waste energy to lift the burdens of humanity they make a net gain for civilization and do not merely transfer a burden from one set of shoulders to another.

In a paper on "High-Potential Long-Distance Transmission and Control," read at the International Electrical Congress at St. Louis in 1904, I said: "At the present time 60,000 volts can be safely handled and 80,000 volts is not out of reach by those experienced; and judging the future by the

*From a paper presented at the International Engineering Congress.

†Consulting engineer, San Francisco, Calif.

past, we may expect to reach 100,000 operating voltage in a few years."

We are already 50 per cent. in excess of the above voltage, and there is no reason to believe we could not design a system for double present voltage if there was the demand for it, and I believe the demand is inevitable in the near future.

I expect to see central stations of 100,000 kw. with 25,000-kw. units become common, and I expect to see trunk transmission lines constructed to connect a large number of these stations throughout the country with branch substations and lines extending practically over the entire country. The prime movers for the generators will be so large as to exclude reciprocating engines of every kind, limiting the prime movers to waterwheels located at favorable water-power sites and steam turbines located at sources of cheap fuel—coal, oil or gas.

When this is accomplished and the energy we require comes from water-power and waste-fuel sources, we will have reached the age of the wise—of "our inheritance." The curve of human efficiency must become flattened and become asymptotic to the line representing 100 per cent., and as this 100-per cent. line is known and we are approaching it with the electric system, I believe the electrical age to be the ideal end of the remarkable series of steps of human progress that has taken place in the past 100 years.

Electrical Engineers Hold Hydro-electric Session

Hydro-electric power with particular reference to supplemental steam power formed the topic of the meeting of the American Institute of Electrical Engineers at Philadelphia on Oct. 11. The session was held in the engineering building of the University of Pennsylvania, President J. J. Carty presiding, and was well attended, although the lack of discussion was somewhat disappointing in view of the importance of the subject and the three excellent papers presented.

At the afternoon session two papers were presented—one on "Supplemental Power for Hydro-Electric Systems," by J. F. Vaughan, and the other on "The Combined Operation of Steam and Hydraulic Power in the Pennsylvania Water and Power Co. System," by J. A. Walls. In the absence of Mr. Walls this was read and discussed by A. S. Loizeaux, of the Consolidated Gas, Electric Light and Power Co. of Baltimore, one of the largest customers of the water-power company.

Mr. Vaughan outlined the functions of the steam plant furnishing relay and supplemental power for the system normally supplied by water power, and illustrated by diagrams in a hypothetical case the division of load between the hydro-electric and the supplemental power. He reviewed the practice of a number of New England companies in utilizing their customers' steam plants for relay service in the case of low water or breakdown and, to a less extent, to help out on the peak load. The contracts with the customers furnishing supplemental power in general provide that on request of the power company the customers shall supply power in such quantities and at such times as it may be required, provided this does not interfere with their regular business. Such power is strictly "off peak" as far as the customer is concerned.

The paper of Mr. Walls dealt with the operation of the Pennsylvania Water and Power Co. plant on the Susquehanna River at Holtwood, Penn. This at present has a maximum installed capacity of 83,000 kw., which is eight times that at minimum flow. An idea of the erratic behavior of the river may be gained from the fact that the maximum flood discharge is 250 times the lowest discharge. The output is taken mostly by a few large customers, and very satisfactory arrangements have been made as a result of test runs, etc., whereby their steam plants are used during low-water periods, thus permitting the water to be stored to handle the peaks. The steam plants also serve for breakdown service, although this necessity has not been as great as was at first anticipated. The water-power company has not found it necessary to have its own steam plant.

In discussing Mr. Wall's paper, Mr. Loizeaux said that the Consolidated Gas, Electric Light and Power Co. had abandoned the use of oil for firing the standby boilers and is now using underfeed stokers with banked fires which can be brought up to full load in about seven minutes. The practice of the company has been to put a sufficient number of steam turbines on the line whenever a storm is approaching and keep them slowly turning over until all danger of interruption of service has passed. He mentioned an arrangement by which the hydro-electric power is purchased at two rates—one, the higher, based on the ability to serve (the low-water capacity), and the other on the additional power which the water-power company is able to furnish most of the time, but which may have to be supplied by the customers' steam plants part of the time.

Following the afternoon session, the members of the Institute were conducted through the new station of the Philadelphia Electric Co., where two turbines of 30,000 and 35,000 kw. capacity respectively, have been installed. An informal dinner was held at the Hotel Normandie, after which the evening session was held. Only one paper was presented; this was by C. A. Adsit and W. P. Hammond and described the Tallulah Falls hydro-electric development[1], which operates under a head of 606 ft. Complete unit costs of the various items of construction were included, the following showing the percentage relation of various expenses on the development as a whole, exclusive of cost of land and property expense.

General construction expenditure	75.575 per cent.
General engineering expense	3.078
General legal expense	1.891
Interest, bonds and advances during construction	11.315
General overhead expense	1.773
Generad contract expense	6.368
Total	100.000

[1]For a complete description of this plant see "Power," Jan. 27, 1914.

Boiler Explosion at East Weymouth, Mass.

The 72-in. by 18-ft. fire-tube boiler in the factory of George E. Strong & Co., shoe manufacturers, of East Weymouth, Mass., exploded at 7:45 a.m. on Oct. 11. The engineer, Cornelius Condrick, was killed outright, but several other men in the adjoining engine room at the time escaped injury. The damage was about $10,000. The boiler room, which was a one-story brick structure on the side of the 3-story wooden factory building, was demolished, bricks being driven by the force of the explosion through every window on that side of the building and even across the street. Several employees were injured by the flying bricks and bits of boiler or fainted in a rush for the exits.

A preliminary investigation indicates that the accident was probably caused by the failure of a lap seam. Acting Chief George C. Neal, of the District Police, has received reports from inspectors that the conditions were identical with those in other explosion cases at Brockton and West Lynn, Mass., in recent years. The loss of life in the Weymouth explosion was limited by the situation of the boiler in a separate brick building. An inspection shows that there had been a constant tearing at the rivets along the lap seam, with a wearing away of the plate to a thickness of about one-sixth of that required to resist the strain with safety. It was impossible to detect the defect by the ordinary boiler-inspection methods.

Since the Grover factory disaster in Brockton, where 65 lives were lost, the installation of lap-seam boilers has been prohibited in Massachusetts, but those of this type already in use have been allowed to remain, the Legislature requiring only a reduced standard of pressure. The Strong Co. had a certificate from the boiler insurance company to carry 84 lb., and it was said that the pressure was only about 80 lb. when the explosion occurred. A similar claim was made at the Grover factory. The problem presented to the district police by the latest disaster is what to do with the lap-seam boilers now in use in manufacturing plants in the state, any one of which may be in a critical condition. Only the week before the Weymouth accident Acting Chief Neal had suggested that the Legislature should do something more than merely reducing the steam pressure on the lap-seam boilers, and that they ought to come out before more lives were lost. There is at present no accurate record of the steam boilers of this type used in Massachusetts, but the one that failed at Weymouth was said to have been 19 yr. old.

OBITUARY

JAMES H. CHASMAR

Capt. James H. Chasmar, U. S. N., retired, for many years connected with the Brooklyn Navy Yard, died in Washington, Oct. 9, in his eightieth year. He was born in New York and received his early education in the public schools of that city. Later he was a student of what was then called the Free Academy and is now the City College of New York. One of his schoolmates was the late arctic explorer, Admiral George

W. Melville, and their friendship was unbroken until the admiral's death. Unlike the majority of high officers of the Navy, Captain Chasmar never attended Annapolis. He entered the Navy during the first year of the Civil War and served through the conflict, after which he was detailed to the U. S. S.S. "Suwanee," then on survey duty. The ship struck an uncharted rock off Prince Edward Island and broke in two, and with the other officers and crew he had a narrow escape from death. When they finally managed to reach shore, they were forced to live for six weeks among the Indians, being finally rescued by the steamship "New World." Captain Chasmar made many cruises, was twice attached to the old "Kearsarge" and was a member of the staff of the "Quinnibaug" during the bombardment of Alexandria by the British navy. He was known as one of the best naval engineers in the service and was in charge of the first machinery building ever done by the Government—the construction of the engines for the cruisers "Cincinnati" and "Raleigh," at the Brooklyn Navy Yard. When the former was placed in commission, Captain Chasmar was her first chief engineer. His last work was done during the Spanish-American War, when he fitted out the converted cruiser "Vulcan," formerly the "Chatham" of the Merchants' and Miners' Line, as a floating machine shop. He took the ship down the coast to Guantanamo Bay, and remained in charge of her until the end of the war.

PERSONALS

Perry Barker has withdrawn from the firm of Arthur D. Little, Inc., and established himself as a fuel engineer at 141 Milk St., Boston.

Francis J. Thompson, formerly chief engineer at the North Carolina College of Agriculture and Mechanic Arts, West Raleigh, N. C., is now master of motive power at the Columbian Paper Co., Buena Vista, Va.

Bryon T. Burt, vice-president of the Rutland Railway, Light & Power Co., Rutland, Vt., has assumed the duties of general manager of that company. He was formerly general manager of the Chattanooga & Tennessee River Power Co., with headquarters at Chattanooga, Tenn.

E. H. Sniffin, formerly vice-president and sales manager of the Westinghouse Machine Co., has been appointed manager of the prime mover department of the Westinghouse Electric and Manufacturing Co. The standard product of the machine company is being handled by the prime mover department of the electric company, Mr. Sniffin directing the sale of the product of the former concern, as he has done in the past. He became associated with Westinghouse, Church, Kerr & Co. in 1888, first as salesman and afterward as sales manager. In 1903, when the machine company organized a sales department, Mr. Sniffin was made sales manager. He was elected vice-president in 1905, the position he held at the time of the organization of the prime mover department of the electric company.

ENGINEERING AFFAIRS

The Electric Power Club will hold its next meeting Nov. 8, 9 and 10, at the Homestead Hotel, Hot Springs, Va.

The Society of Automobile Engineers held a meeting Oct. 21, in New York, at which were shown three industrial motion-picture films illustrating the manufacture of "National" pipe from the start at the Mesaba ore ranges in Minnesota, through the various steps to the finished product.

The Detroit Engineering Society held a meeting Oct. 15, at which Prof. Edward Orton, Jr., dean of the Engineering School of the Ohio State University, spoke on "Refractory Materials." His talk considered their selection, testing and uses. The next meeting of the society will be held Oct. 29, when Horace M. Allen will speak on "Corea—Past and Present."

National Electric Light Association—John Hunter, chief engineer of the Union Electric Light and Power Co., of St. Louis, Mo., who served as a member of the International Jury of Awards at the Panama-Pacific Exposition, entertained the St. Louis section of the National Electric Light Association with an illustrated talk upon the exposition on the evening of Oct. 14. About 200 members were present, and Mr. Hunter's explanation of the large number of lantern slides which he had accumulated was very much enjoyed.

The American Association of Engineers is planning a national convention, to be held in Chicago Dec. 10-11. All engineering societies have been invited to send official representatives to the convention to assist in attempts to solve a few of the welfare problems confronting the engineer. The following national membership committee has been selected to push the organization of local chapters in various parts of the United States: A. H. Krom, assistant engineer of the Illinois State Public Utilities Commission; F. H. Newell, professor of civil engineering, University of Illinois; S. Steenerson, engineer of the Minnesota Highway Commission, Crookston, Minn.; Edwin R. Webster, civil engineer, Marion, Iowa; Daniel B. Luten, bridge engineer, Indianapolis; O. L. Dent, referee in drainage matters, Bemidji, Minn.; R. A. West, civil engineer, Tye River, Va.; Israel L. Beerman, engineer of the New York State Highway Commission, Fillmore, N. Y.; Harold Almert, consulting engineer, Chicago; W. N. Winter, electrical engineer, Hood River, Ore.; H. L. Holderman, civil engineer, Chicago, Minneapolis & St. Paul Ry., Lewiston, Mont.; Ernest McCullough, consulting engineer, Chicago; George C. Keech, electrical engineer, Chicago, and A. T. North, contracting engineer, Chicago.

NEW PUBLICATIONS

TEXTBOOK OF ENGINEERING THERMODYNAMICS. By Charles E. Lucke, professor of mechanical engineering at Columbia University, and John J. Flather, professor of mechanical engineering at the University of Minnesota. Published by the McGraw-Hill Book Co., Inc., New York City. Cloth; 688 pages, 6x9 in.; 39 tables; 139 illustrations. Price, $5.

This book is a reprint of Professor Lucke's massive volume of 1,200 pages, published three years ago under the title, "Engineering Thermodynamics." Most of the original text has been retained, but the chapters have been made shorter and a large number of the problems have advisedly been omitted. The treatment covers, first, the general principles of work and power, without regard to heat; next, the effect of changes in heat content of substances without change of state; and, finally, the transformation of heat and work by changes of substance condition. In its new form the book is particularly valuable, for reference and to advanced students, as a comprehensive exposition of the application, as modified by practice, of the laws of thermodynamics to heat apparatus and machines. The tables and diagrams essential to the proper teaching of the subjects have been kept in the text, but the others to the extent of nearly 200 pages are given in the "Handbook."

HANDBOOK OF THERMODYNAMIC TABLES AND DIAGRAMS. By C. E. Lucke and J. J. Flather. Published by the McGraw-Hill Book Co., Inc., New York City. Cloth; 238 pages, 6x9 in.; 87 tables; 82 diagrams. Price, $1.50.

This collection of data is reprinted from "Engineering Thermodynamics" and includes 140 pages of tables of conversion units, properties of vapors, composition of fuels, physical constants and correlated information relating to thermodynamics. The second part of the book is given over to diagrams showing the work and power relations in heat apparatus, efficiencies of various gas cycles, comparisons of air and steam flow, properties of air, water vapor, steam and other gases, temperature-entropy diagrams and work done by refrigerating agents. Prefacing the diagrams is a description of their construction accompanied by an explanation and examples of their use. Some of the data in this book are found in every handbook, most of them only in few; but the collection should be useful to those making any extensive thermodynamic calculations.

WATER POWER OF THE CASCADES

The United States Geological Survey, in coöperation with the Washington State Board of Geological Survey, has made a comprehensive survey of the water resources of the Cascade Range in that state. Water-Supply Paper 313, issued by the Federal Survey, entitled "Water Powers of the Cascade Range, Part II," is the second of a series of reports resulting from this work, the first having been issued as Water-Supply Paper 253. This second report deals mainly with the drainage basins of Cowlitz, Nasqually, Puyallup, White, Green and Cedar rivers. It includes all monthly estimates of river discharge as well as summaries of the available power in each basin. The summaries are computed from the average flow for the lowest week on record and from the flow that could be realized from possible storage. Copies of both Water-Supply Papers 253 and 313 may be obtained free from the Director of the Geological Survey, Washington, D. C.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR 1914. Published by the Government Printing Office, Washington, D. C. Cloth; 729 pages, 6x9 in.; numerous illustrations. Price, $1.10.

While a small part of this book covers the operation and condition of the institution during the preceding year, over three-quarters of it is given over to papers embracing a considerable range of scientific investigation and discussion. Among them are several of applied scientific interest. The paper on logarithms, by Prof. M. d'Ocagne, discusses the important results in practice and theory that have sprung from Napier's invention. A popular lecture by Prof. Andrew Gray explains the principle of the gyrostat and its application to such purposes as pendulums, compasses, dirigible torpedos, electric motors and steadying ships. The paper also considers the gyrostatic action in dynamos and turbines used on board ships. The paper by Preston F. Miller on recent developments in the art of illumination deals also with the materials and science relating to lighting by gas and electricity. More than half the book is devoted to papers on zoölogy, geology, biology and other branches of pure science.

BUSINESS ITEMS

The Diamond Power Specialty Co., Detroit, Mich., has appointed the Steam Equipment Manufacturing Co., Jenkins Arcade Building, Pittsburgh, as representative in Pittsburgh and vicinity.

In order to render return condensate bright, clear and free from cloudy or emulsified oil, the Methodist Book Concern in New York is installing a duplex Krause absorbent feed-water filter, manufactured by A. E. Krause, 345 Fairmount Ave., Jersey City, N. J.

Arturo R. Calvo has been made manager of sales of the Permutit Company, 30 East 42nd St., New York. Mr. Calvo has had a wide experience in water rectification, having been contracting engineer of the Reisert Automatic Water Purifying Co. for five years and having been with the Permutit Company since its inception. Mr. Calvo is a graduate of West Point, class of 1907, and after graduation engaged in engineering, eventually specializing in the problems of water purifying and rectification.

The Whitlock Coil Pipe Co., Hartford, Conn., has recently made installations of American Standard Copper copper coil feed-water heaters as follows: Brainerd & Armstrong Co., Norwich, Conn., 150 hp.; Germania Life Insurance Co., New York, N. Y., 300 hp.; Tennessee Oak Flooring Co., Nashville, Tenn., 700 hp.; William Ganshow Co., Chicago, Ill., 250 hp.; City of Cleveland, Cleveland, Ohio, 2,000 hp.; Hotel Rudolph, Atlantic City, N. J., 400 hp.; American Thread Co., Milford, N. H., 400 hp.; Carton Belting Co., Boston, Mass., 100 hp.

The Southwark Foundry and Machine Co., Philadelphia, has received an order for two four-cylinder Southwark-Harris valveless Diesel engines, arranged to drive direct-connected to two Southwark centrifugal pumps for the Fabius River Drainage District. The engines are 12x21, to run at 200 r.p.m. and to develop 450 i.hp. There is a 20-hp. auxiliary engine to drive auxiliary compressor and electric generator, with compressor, generator service tank, etc., and two horizontal centrifugal pumps with a capacity of 47,500 gal. per min. each, against a head of 16.2 ft. at 200 r.p.m., requiring 250 hp. The discharge opening is 42 in., and the two suction openings are 36 in. each.

Did you read the Lunkenheimer Company's advertisement in the October 5th issue? An interesting example of how a typographical error can change the meaning of a sentence, is shown in the second paragraph. As the compositor set it, the sentence reads "The by-pass can **only** be used for warming the unit before starting." As every engineer has probably assumed, the sentence should have read "The by-pass can **also** be used for warming the unit before starting." Readers are requested to refer to the advertisement again, and to write for descriptive booklet No. 579, which gives the full details of the Lunkenheimer Balanced Throttle Valve for Steam Power Units.

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Drip Pipes should not be less in size than ¾ in., on account of liability to mechanical injury, inside corrosion and stoppage.

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A Flywheel Burst in the engine room of the Natchez Oil Co., Natchez, Miss., on Sept. 21. The engine room was smashed to pieces, portions of the flywheel being hurled hundreds of feet. One man was instantly killed.

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Advice by a Chinese Grand Secretary—If you wish to intrigue successfully and to rise in the world, make your friends at Court. If you would be reckoned a super-official, avoid all reference to vexed questions. The key to success in official life is to take things easily. In all your duties be plausibly evasive: never criticise adversely and never condemn. An absence of friction conduces to official advancement. In dealing with your colleagues, be yielding and soft-spoken, cover up their defects, but avoid praising their virtues. By so doing you may comfortably rise to Grand Secretary, and leave behind you a fragrant memory imperishable.—"Indian Engineer."

NEW EQUIPMENT

Mass., Chicopee—The Chicopee Electric Light Department plans to install four 200-hp. tubular boilers, three 500-kw. generators, one 50- and three 25-kw. motors, three surface condensers and two feed pumps. Address E. A. Miller, Chicopee Electric Light Department.

Mass., Salem—The Salem Electric Light Co. plans to make extensions to the engine and boiler room and will require 3,000-hp. boiler and 6,250-kw. generator. Address H. Kingley, Salem Electric Light Co.

Mass., Southwick—The Southwick Electric Light Co. will erect a power plant and will install a 100-hp. engine.

N. Y., Syracuse—The Hammond Steel and Forging Co. is making additions to its boiler and machine shop.

N. J., Trenton—The Ajax-Grieb Rubber Co. plans to erect a building which will include engine, generators and boilers for its power plant. Horace De Lisser is Chn. of Bd. of Dirs.

N. C., Raleigh—The Carolina Power and Light Co. plans to make improvements to its plant and will probably install additional generating equipment. F. P. Ernst is Ch. Engr.

Fla., West Palm Beach—The Ariston Ice and Electric Co. will enlarge its plant at West Palm Beach.

Miss., Jackson—R. L. Benson, who recently purchased the plant of the Capital Light and Power Co., will expend about $15,000 in purchasing new equipment and making extensions to the plant.

La., Kinder—The power plant of the Peavy-Byrns Lumber Co. was recently destroyed by fire.

Tenn., Afton—L. D. Gastiger Co. will construct a $100,000 dam in the Chucky River for the purpose of developing electricity.

Tenn., Memphis—J. F. Freeman, together with several other business men, purchased the plant of the Crittenden Power Co. The same will be improved and the business will continue as the Earle Light, Power and Ice Co.

Ky., Flemingsburg—The Flemingsburg Light and Ice Co. will replace its present dynamos with a 2,300 alternating-current type engine.

Ky., Louisville—Louisville Gas and Electric Co. will erect a substation on Stevens Ave., at a cost of $13,000.

Ohio, Cygnet—The city has voted bonds for $8,000 for the installation of a municipal electric-light plant.

Ohio, West Union—Charles Riffle plans to install a large crude-oil engine and other equipment in his electric-light plant.

Iowa, Clermont—C. Miller & Sons will spend about $20,000 on improvements to the electric-light plant.

Minn., Brownsdale—H. C. Volkman has applied for a franchise to install and operate an electric-light plant.

Kan., Perry—City Council will hold an election Oct. 28 to vote $5,000 bonds for enlarging and improving the power plant.

Mont., Glasgow—The town plans to issue bonds for the construction of a municipal electric-light plant.

Mo., Springfield—E. M. Stevens & Co., Commerce Bldg., Kansas City, is preparing preliminary plans for the construction of a $400,000 electric-light plant. Bond election will soon be held.

Mo., Gallatin—Bids will be received until Oct. 28 by H. H. Stout, Act. Mayor, for the construction of a power plant. In the specification are included 2 Diesel-type oil engines of 100- and 125-hp. capacity, one 75-kw. generator, switchboard, etc., two centrifugal pumps with motors, also miscellaneous equipment.

Mo., Poplar Bluff—Bids will be received by H. H. Wilcox, City Clk., until 2 p.m., Nov. 3, for the construction of a municipal electric-light and power plant, consisting of a brick power house, 300-hp. water-tube boiler, steam engines and accessories, Diesel-type oil engine, alternating-current generators and equipment, switchboard and complete distribution system. The Fuller-Coult Co., St. Louis, Mo., is Consult. Engr.

Mo., Poplar Bluff—Reported that the Bimel-Ashcroft Co. will purchase about 30 motors and will secure current from the Missouri Public Utilities Co.

Tex., Denison—The Texas Power & Light Co. has purchased a tract of land and will erect a large power plant. Work will start about Jan. 1.

Colo., Alamosa—The Colorado Power Co. will spend $20,000 in improving its plant. J. V. Anderson is local Mgr.

Idaho, Idaho Falls—James McMillan has applied for a franchise to install a gas heating, lighting and power system.

Ore., Portland—About $20,000 will be spent by the Coast Culvert and Flume Co. on improvements to its plant at Kanton Station. These include the purchase of power equipment.

Ont., Kingston—A. Davis & Son, Ltd., is in the market for one 125- to 150-hp. Wheelock engine; one 100-kw., 550-volt, 60-cycle, three-phase alternating-current generator, one 100-kw. direct-connected, 550-volt, 60-cycle, three-phase, alternating-current generating set.

Ont., Toronto—The Hydro-Electric Commission will erect a substation at Gerrard St. and Carlow Ave. to cost about $60,000. Equipment is required.

Ont., West Lorne—The Town Council plans to erect a power and light plant, estimated to cost $15,000. J. Robinson is Town Clk.

Alta., Calgary—The Alberta Hydro-Electric Power Co. will erect a power plant at Calgary. A. Fawkes is Consult. Engr.